US009134003B2

(12) United States Patent
Inoue et al.

(10) **Patent No.: US 9,134,003 B2**
(45) **Date of Patent: Sep. 15, 2015**

(54) **AUTOMOTIVE HEADLAMP, HEAT RADIATING MECHANISM, LIGHT-EMITTING APPARATUS AND LIGHT SOURCE FIXING MEMBER**

(75) Inventors: **Takashi Inoue**, Shizuoka (JP); **Tetsuya Suzuki**, Shizuoka (JP); **Akihiro Matsumoto**, Shizuoka (JP); **Naoki Sone**, Shizuoka (JP); **Takanori Namba**, Shizuoka (JP); **Hidetada Tanaka**, Shizuoka (JP)

(73) Assignee: **KOITO MANUFACTURING CO., LTD.**, Minato-Ku, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 511 days.

(21) Appl. No.: **13/493,330**

(22) Filed: **Jun. 11, 2012**

(65) **Prior Publication Data**

US 2012/0314436 A1 Dec. 13, 2012

(30) **Foreign Application Priority Data**

Jun. 13, 2011 (JP) 2011-131425
Jun. 28, 2011 (JP) 2011-143274
Jun. 30, 2011 (JP) 2011-146267
Jan. 10, 2012 (JP) 2012-002289

(51) **Int. Cl.**
F21V 21/00 (2006.01)
F21S 8/10 (2006.01)

(52) **U.S. Cl.**
CPC ***F21S 48/328*** (2013.01); ***F21S 48/1109*** (2013.01); ***F21S 48/1159*** (2013.01); ***F21S 48/321*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0126494 A1 9/2002 Tanaka et al.

FOREIGN PATENT DOCUMENTS

CN	1884906	A	12/2006
CN	101440923	A	5/2009
CN	102032516	A	4/2011
JP	2005-32661		3/2005
JP	2007-305455	A	11/2007
JP	2008-186796	A	8/2008

OTHER PUBLICATIONS

Chinese Office Action (The First Office Action) dated Apr. 3, 2014, issued by the State Intellectual Property Office of the People's Republic of China in corresponding Chinese Patent Application No. 201210192590.3, and English language translation of Office Action. (14 pages).

Chinese Second Office Action dated Nov. 25, 2014 issued in the corresponding Chinese Patent Application No. 201210192590.3 and English language translation (14 pages).

Japanese Notification of Reason(s) for Refusal dated Jan. 27, 2015 issued in the corresponding Japanese Patent Application No. 2011-146267 and English translation (5 pages).

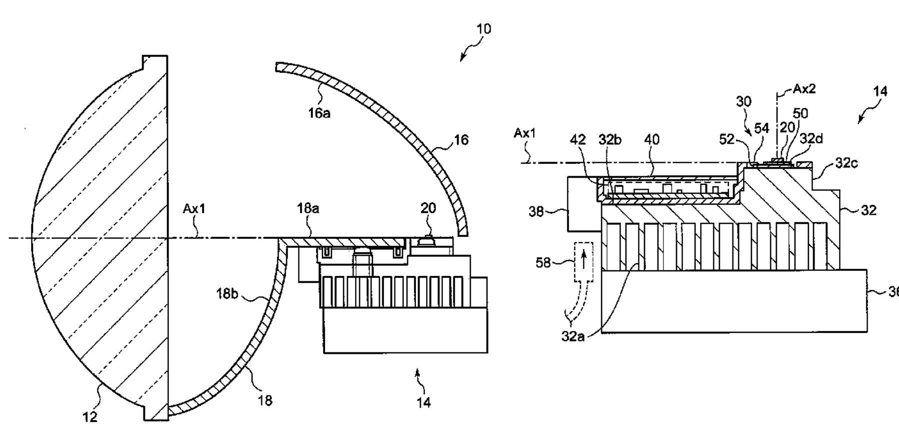
Primary Examiner — Joseph L Williams

(74) *Attorney, Agent, or Firm* — Buchanan Ingersoll & Rooney PC

(57) **ABSTRACT**

In an automotive headlamp, a light-emitting module is configured such that a light-emitting element and a control circuit unit for controlling the lighting of the light-emitting element are structured integrally with each other. A control circuit unit in a position anterior to the light-emitting element in a lamp unit is located below a shade section so that the control circuit unit can be clear of the path of light used to form a low beam light distribution pattern of the light emitted by the light-emitting element. In this setting, the light-emitting element is so located that a main optical axis Ax**2** is perpendicular respect to an optical axis Ax**1** of the lamp unit and that a light-emitting portion of the light-emitting element protrudes higher than the control circuit unit in the direction of the main optical axis Ax**2**.

8 Claims, 25 Drawing Sheets



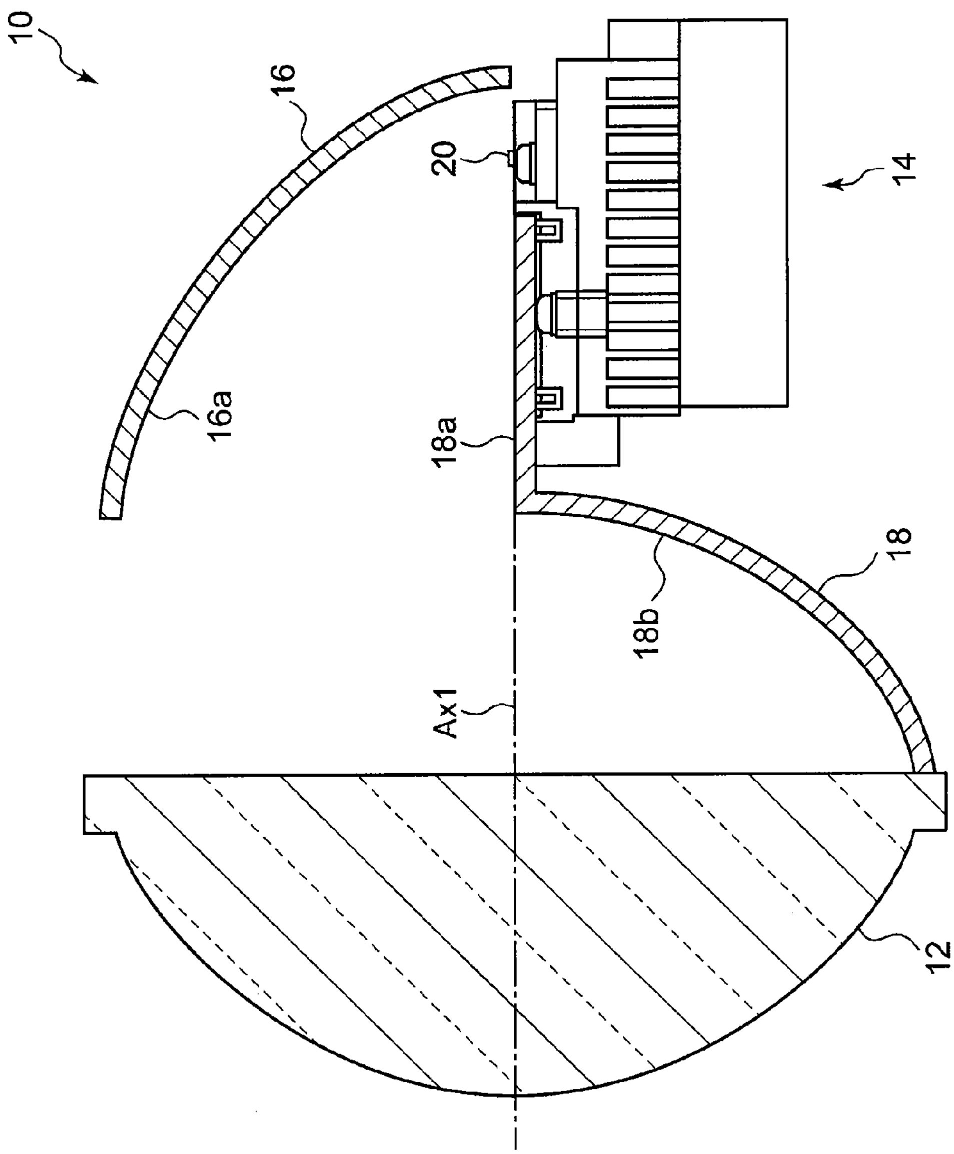


FIG.1

FIG.2A

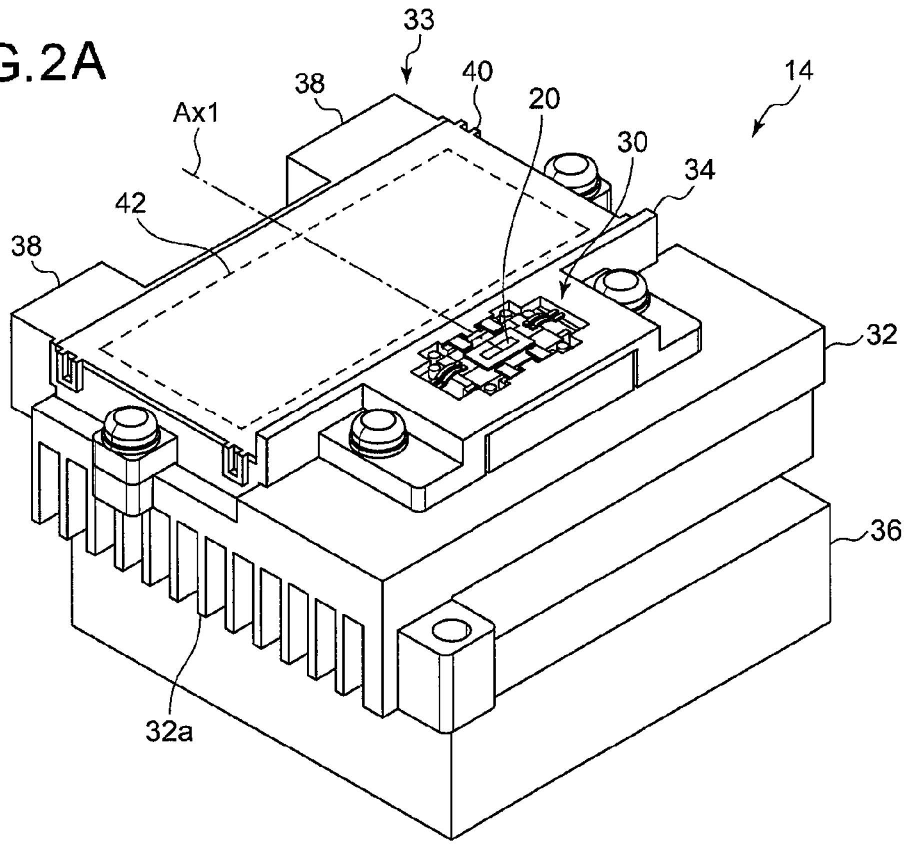

33
38
40
20
30
34
14
Ax1
42
38
32
36
32a

FIG.2B

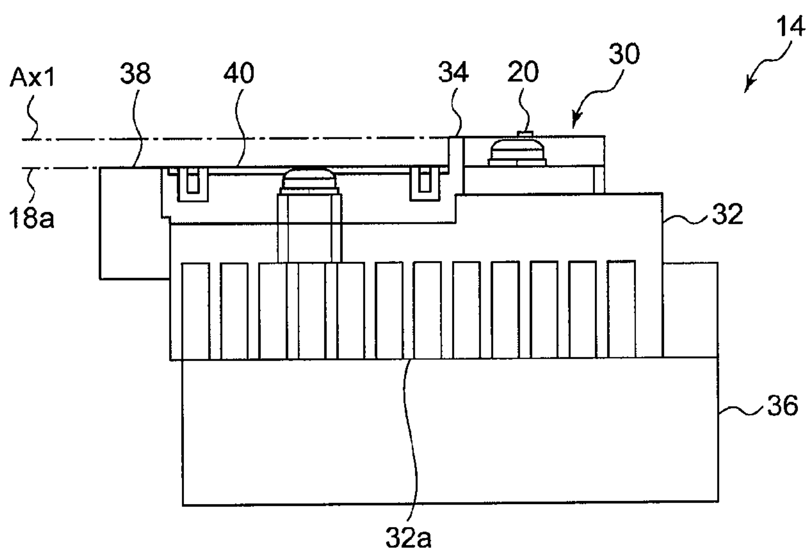

14
30
Ax1
38
40
34
20
18a
32
36
32a

FIG.3

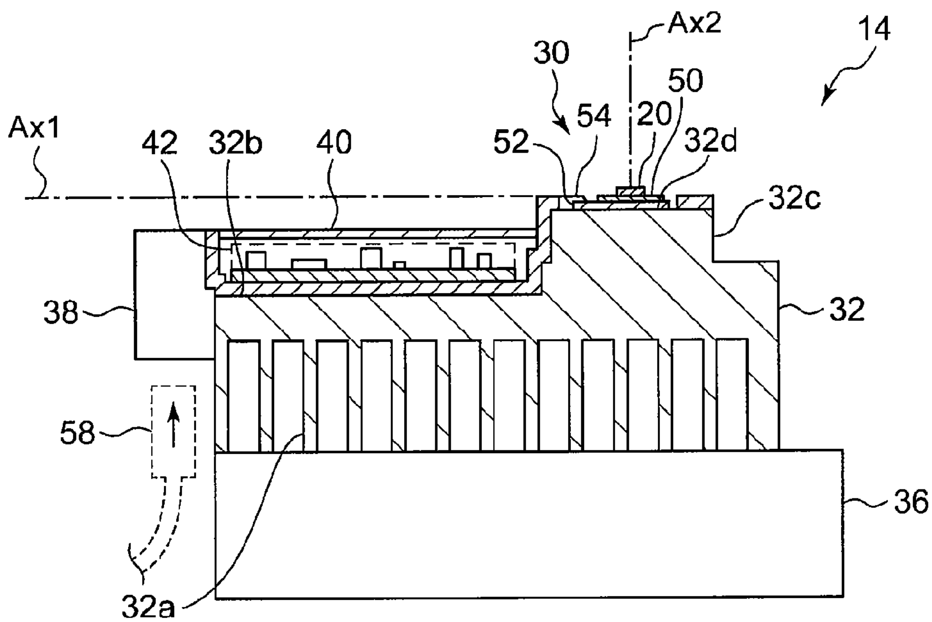

Ax2
14
30
50
54
20
Ax1
42
32b
40
52
32d
32c
38
32
58
36
32a

FIG.4

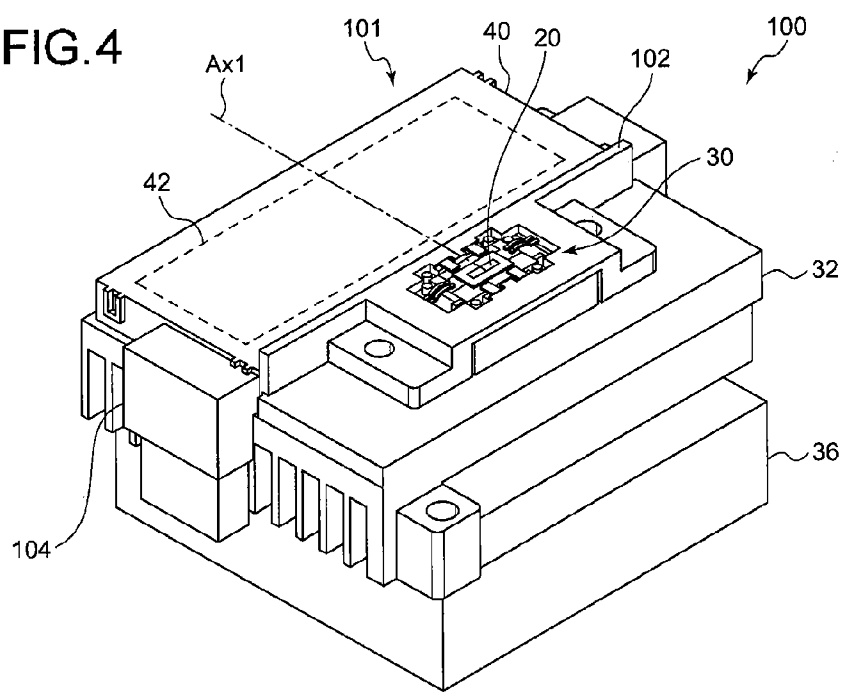
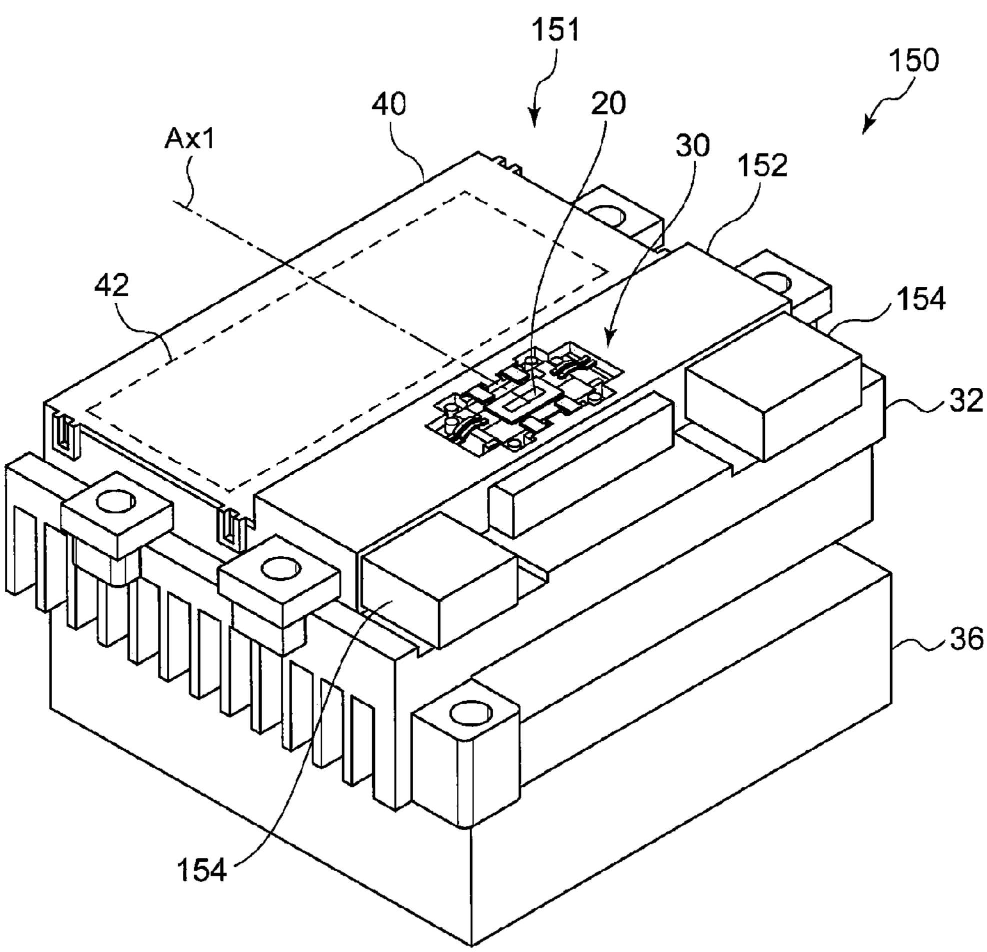

101
40
20
100
Ax1
102
30
42
32
36
104

FIG. 5



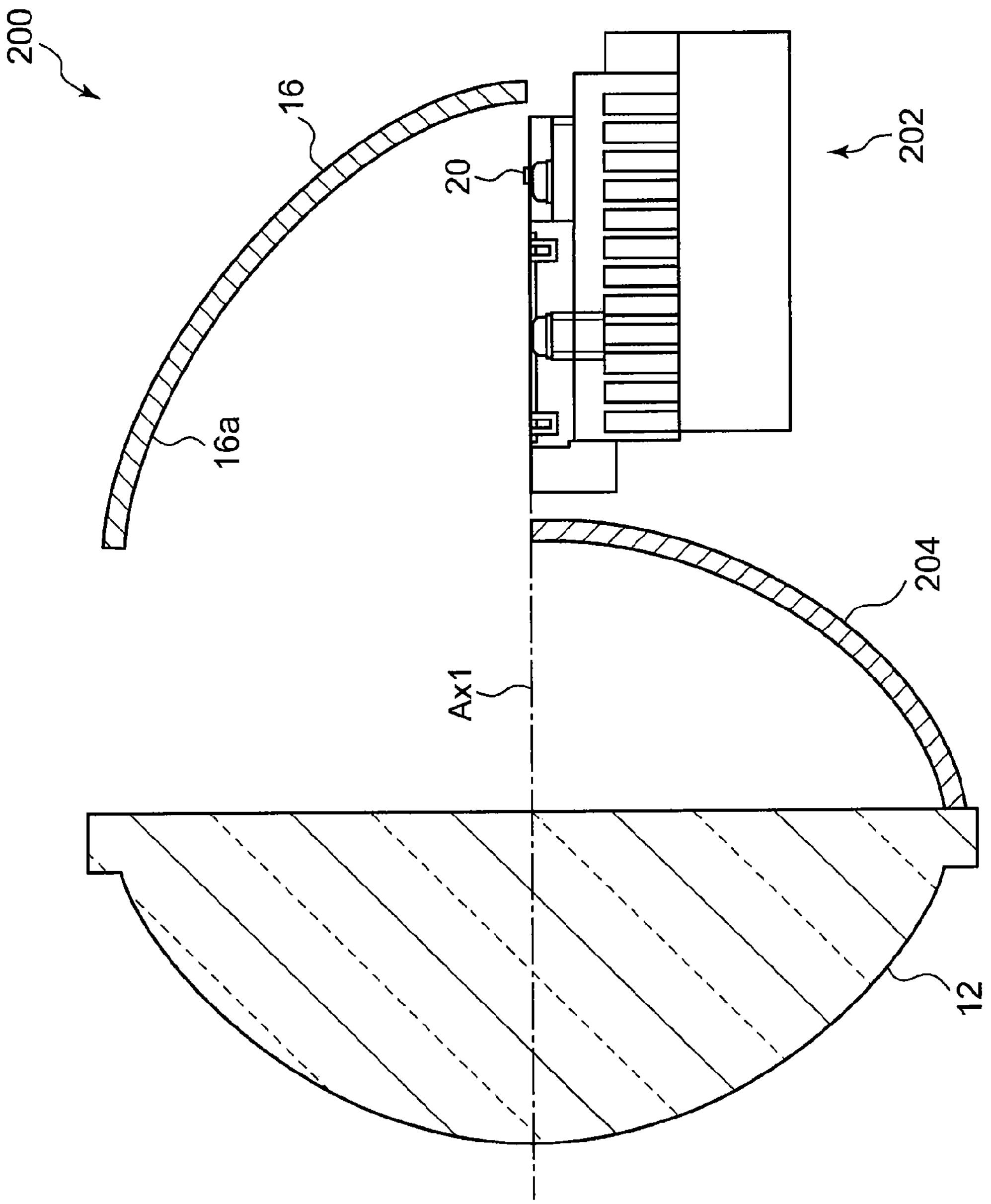


FIG.6

FIG.7A

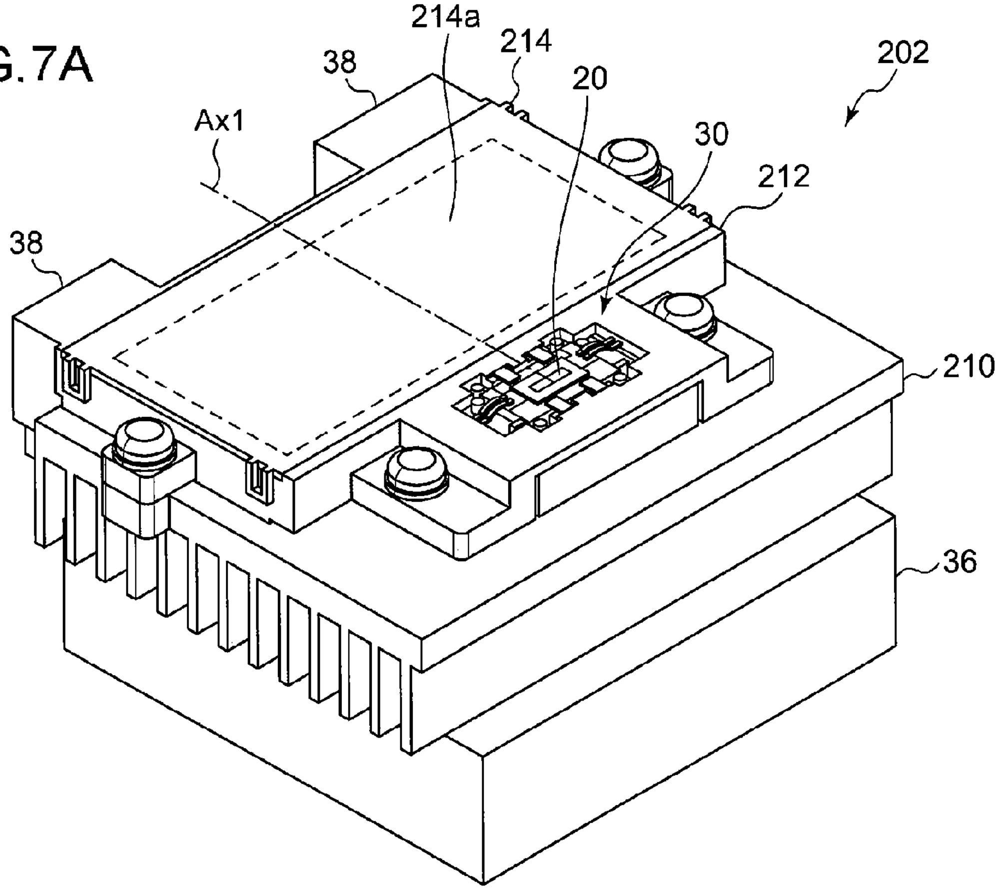

214a
214
38
20
202
Ax1
30
212
38
210
36

FIG.7B

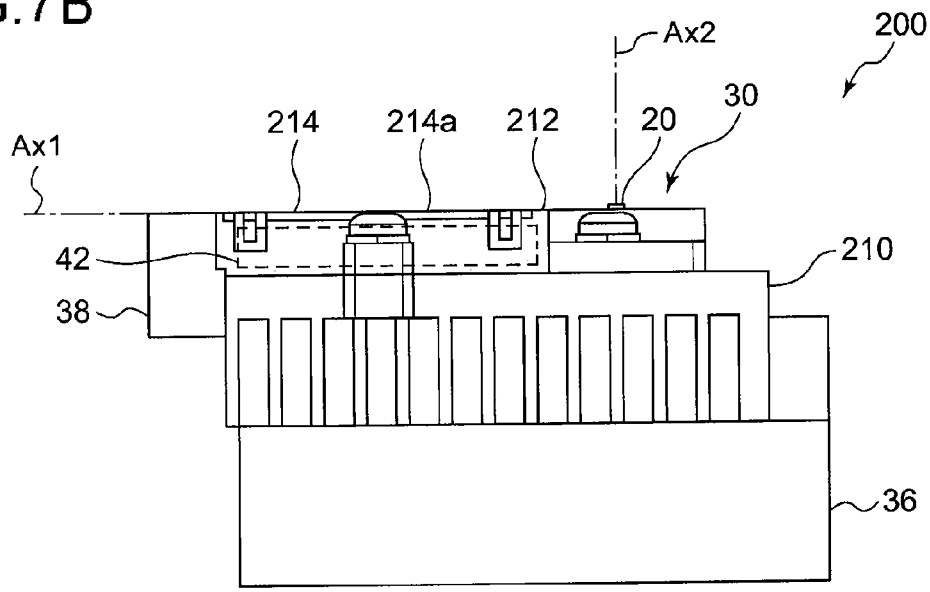

Ax2
200
30
214
214a
212
20
Ax1
210
42
38
36

FIG.8

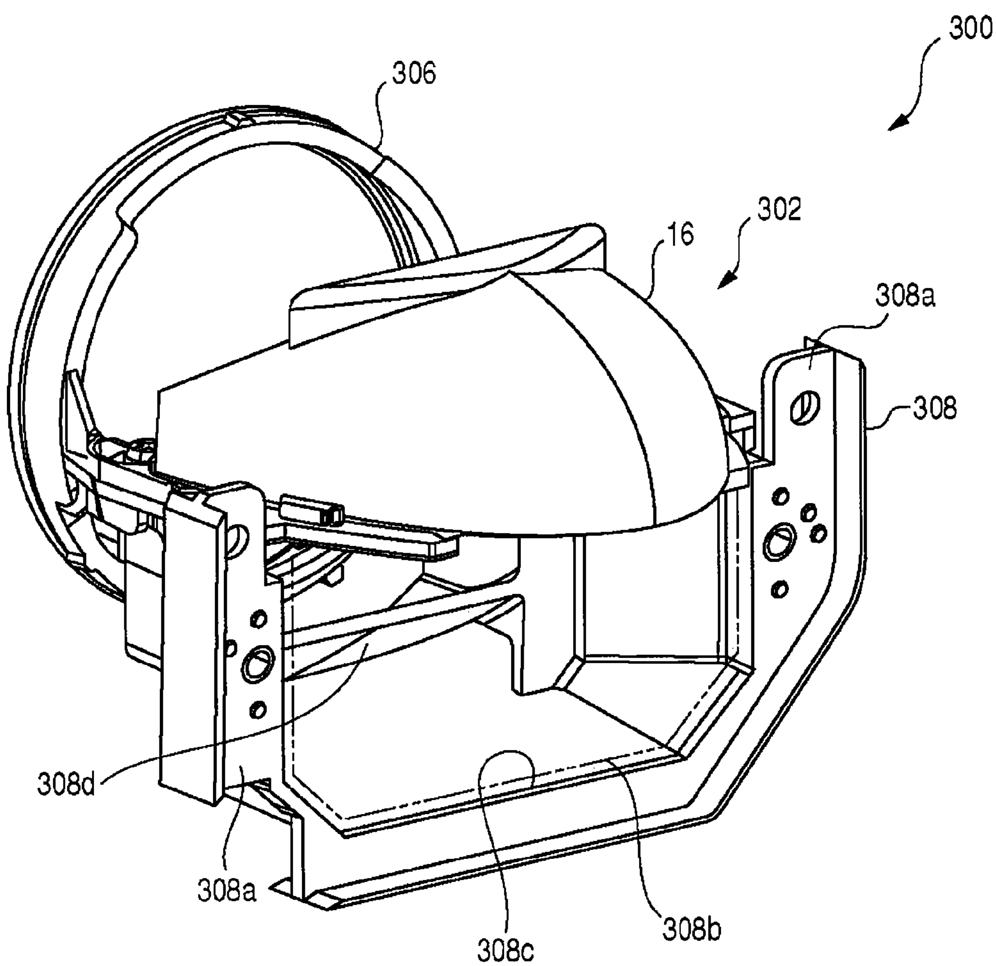


FIG.9

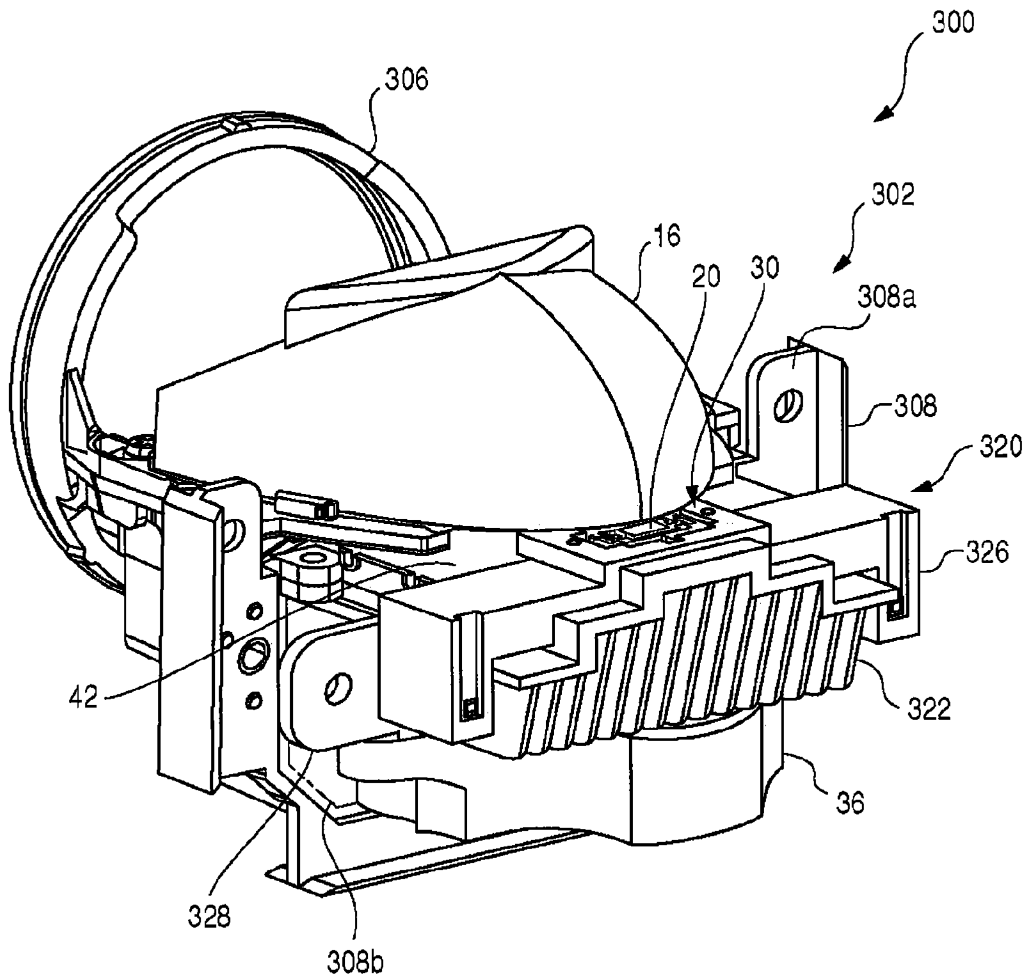


FIG.10

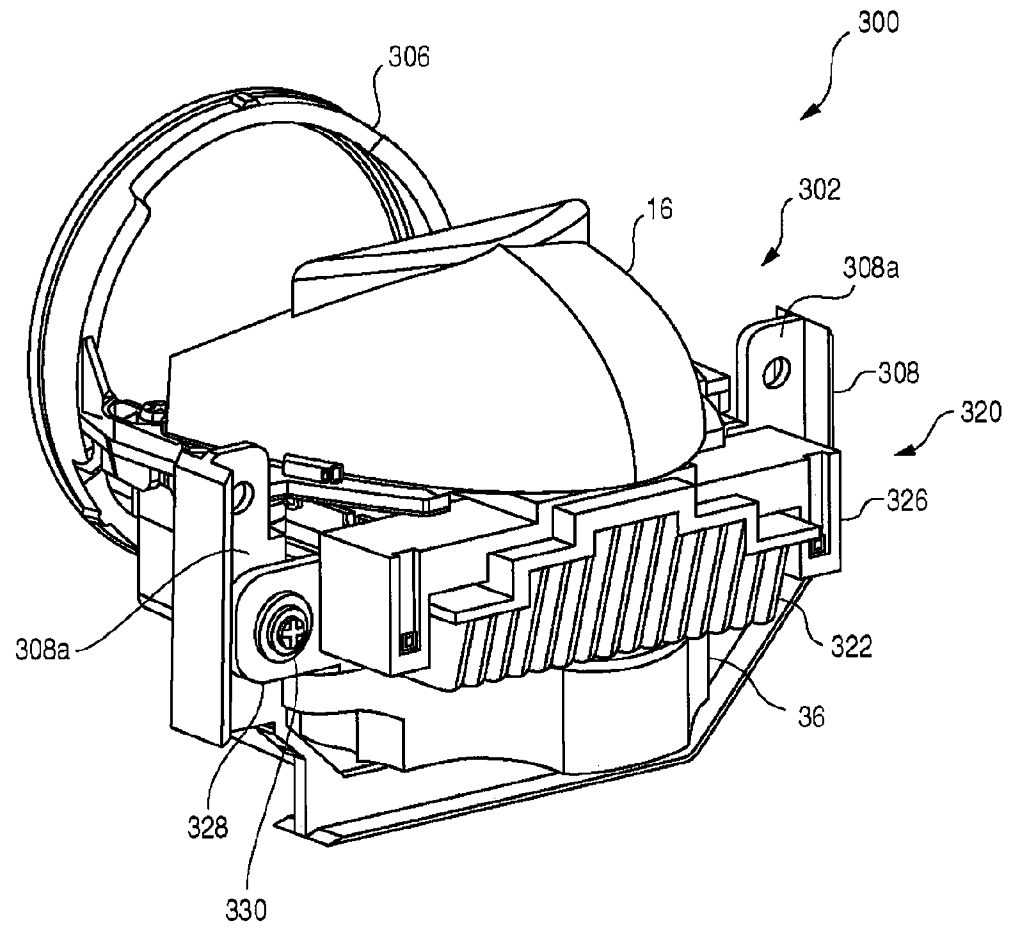


FIG.11

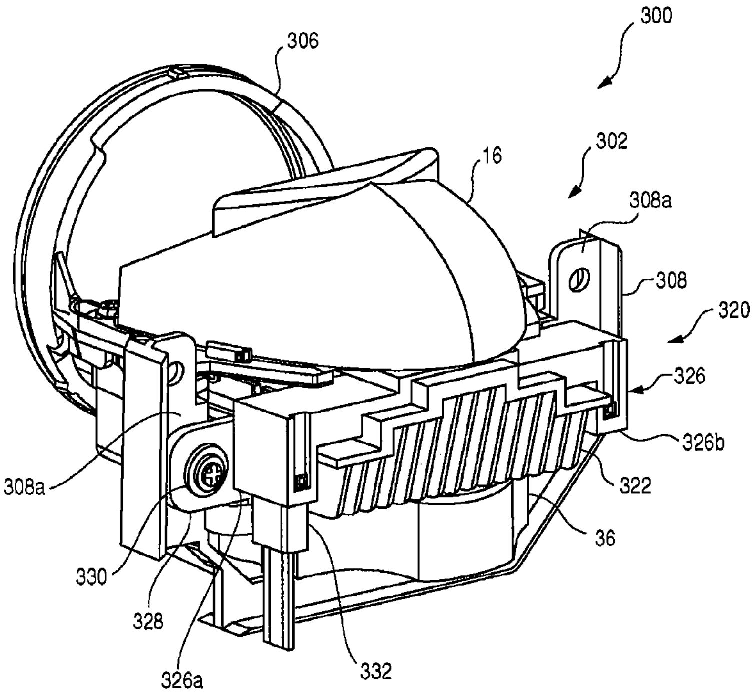

300
306
302
16
308a
308
320
326
326b
322
36
308a
330
328
326a
332

FIG.12

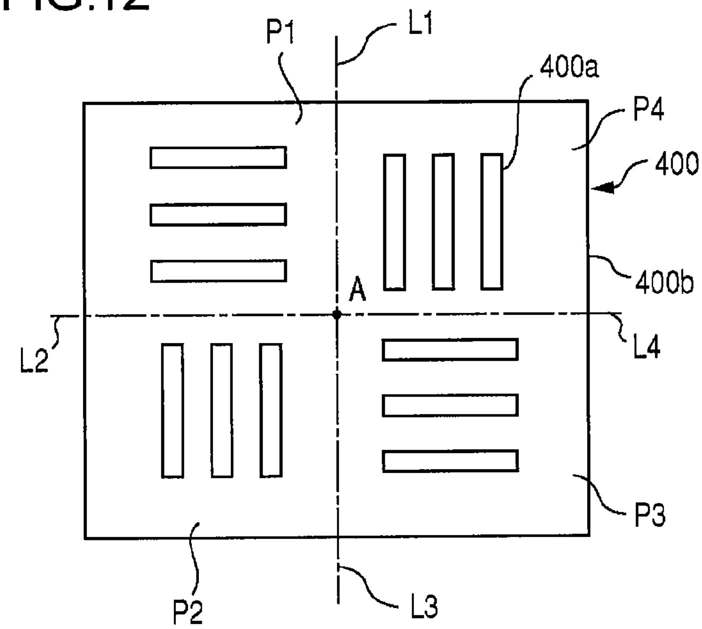
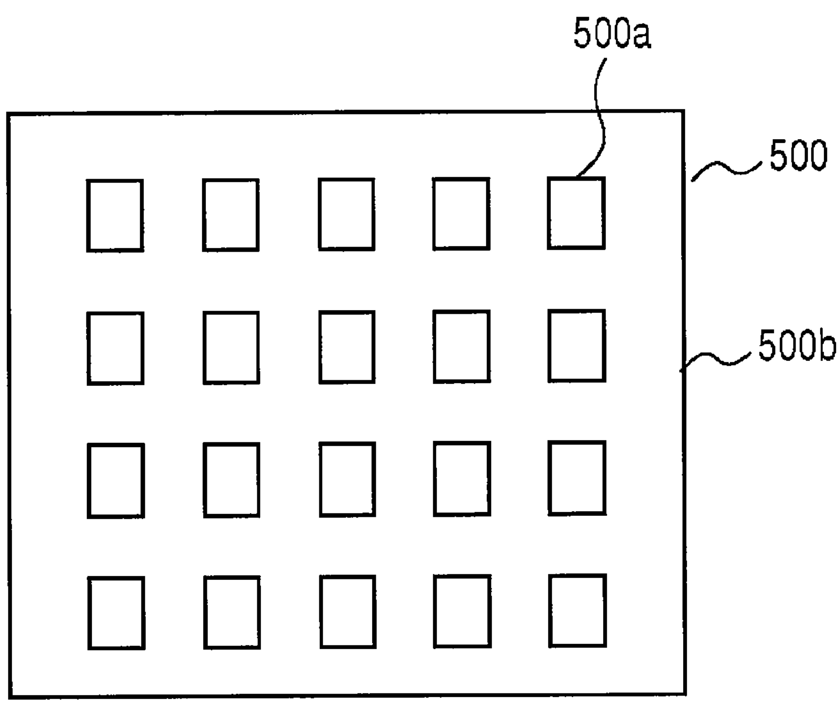

P1
L1
400a
P4
400
400b
A
L2
L4
P3
P2
L3

FIG.13



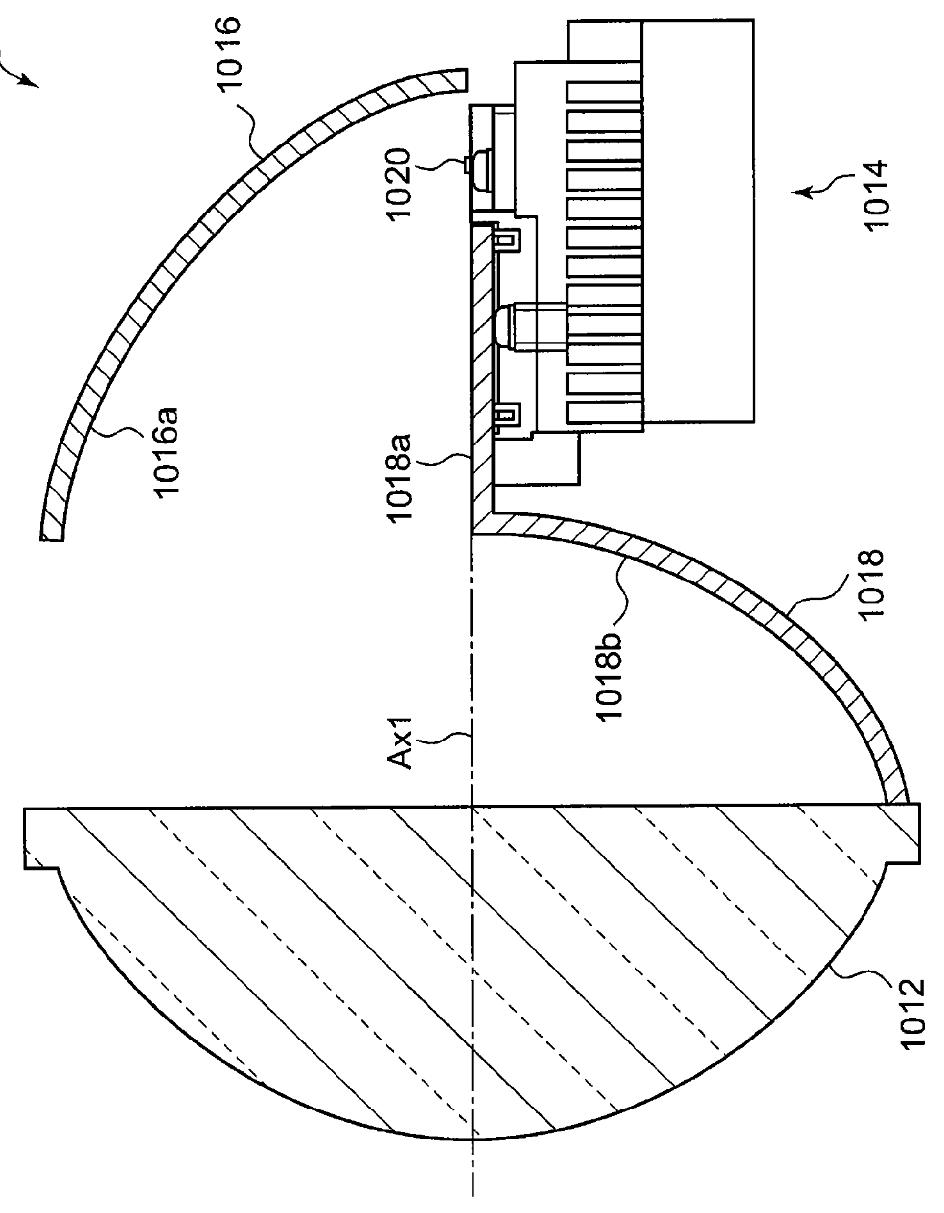


FIG.14

FIG.15A

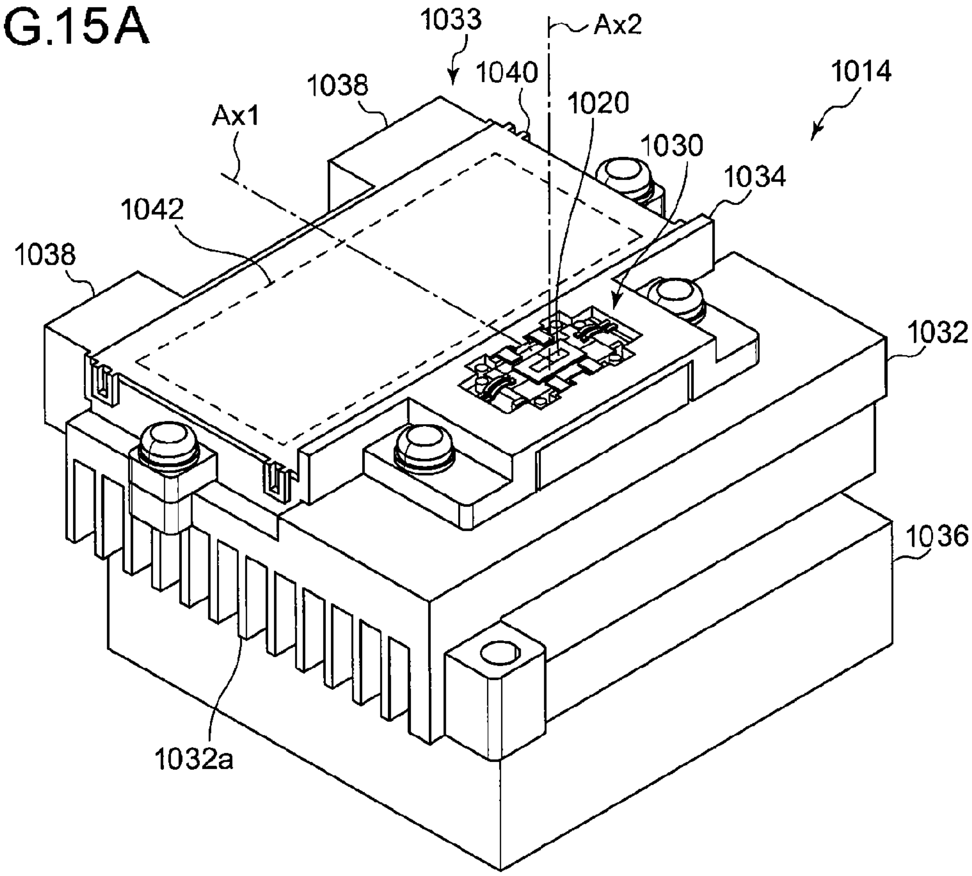


FIG.15B

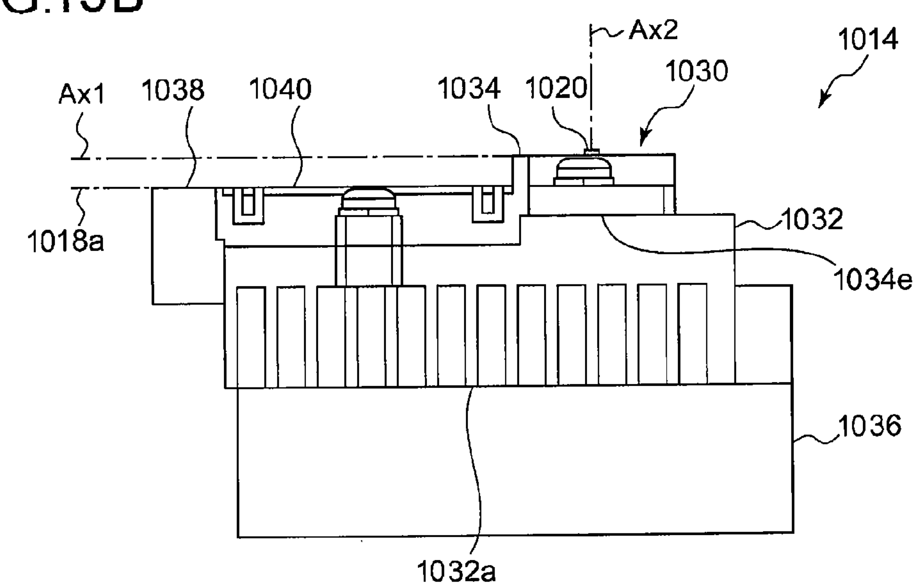


FIG.16

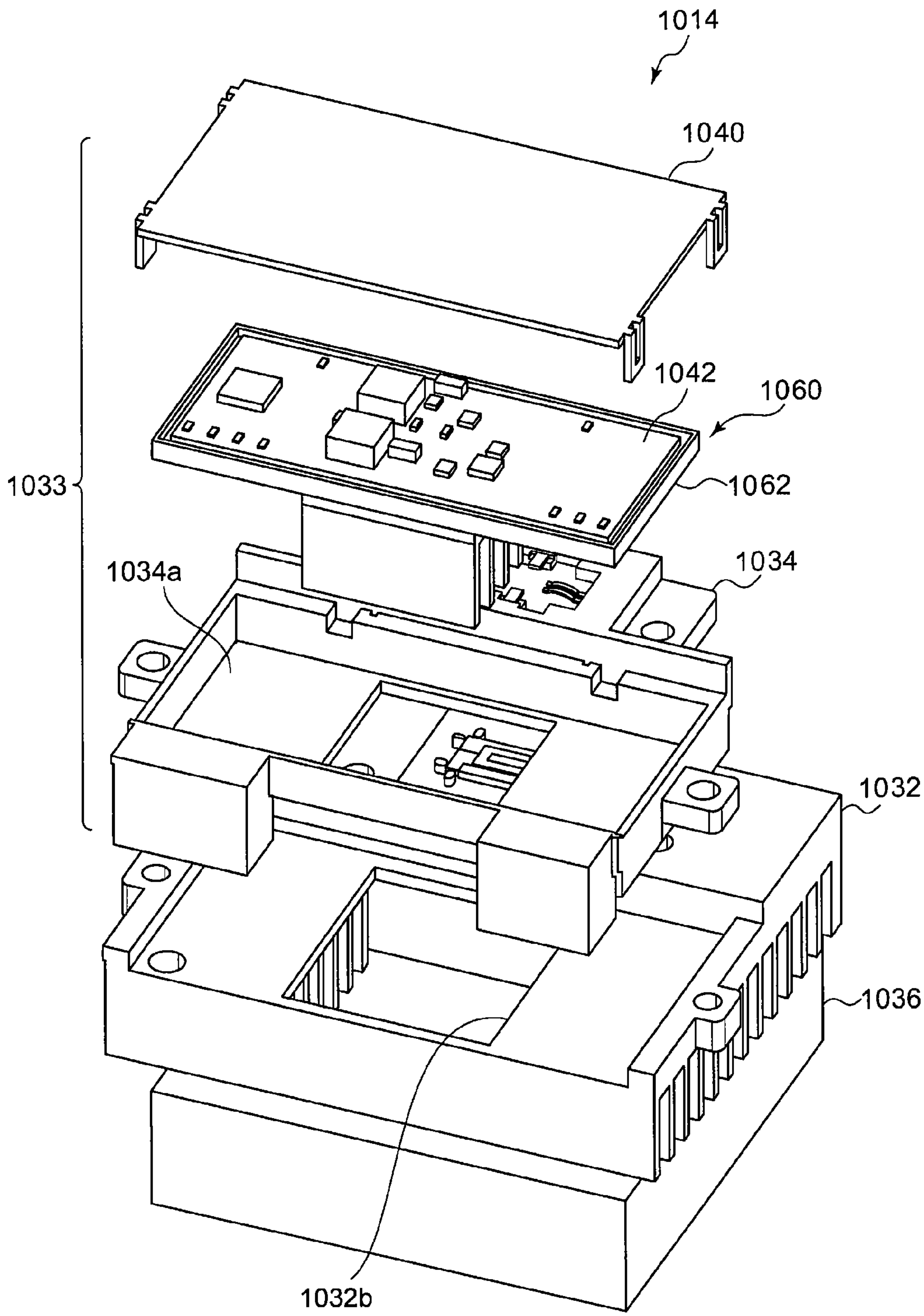


FIG.17

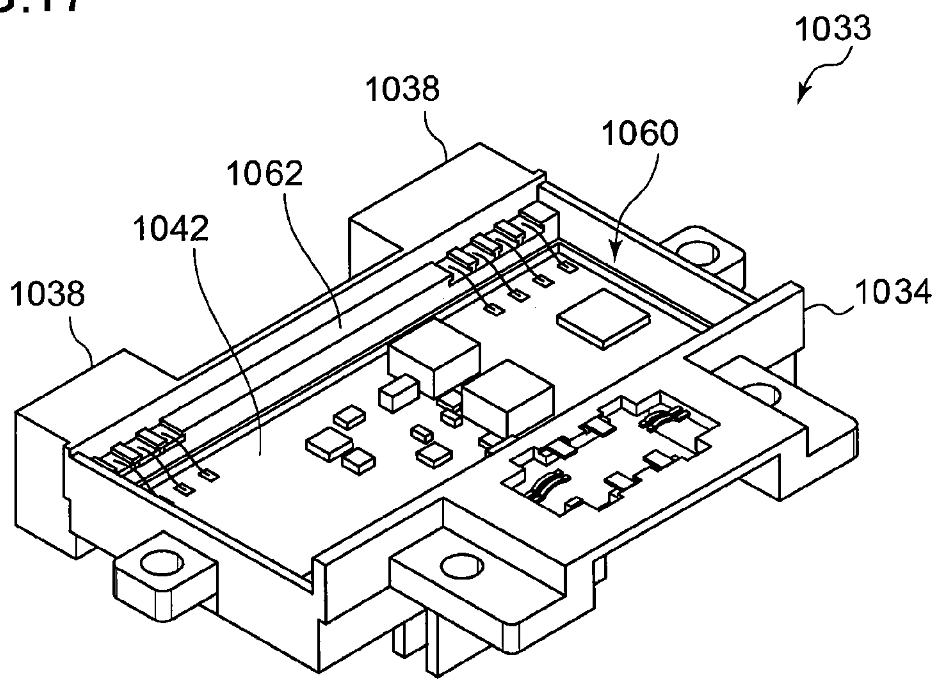


FIG.18B

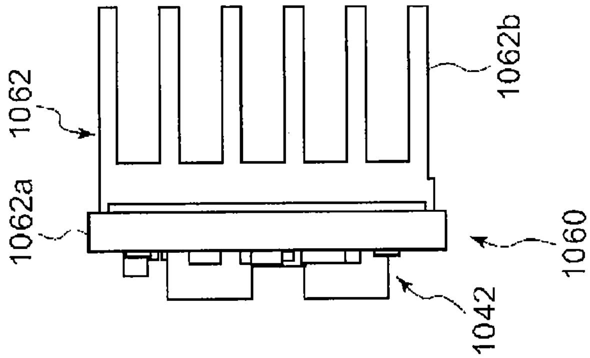


FIG.18A

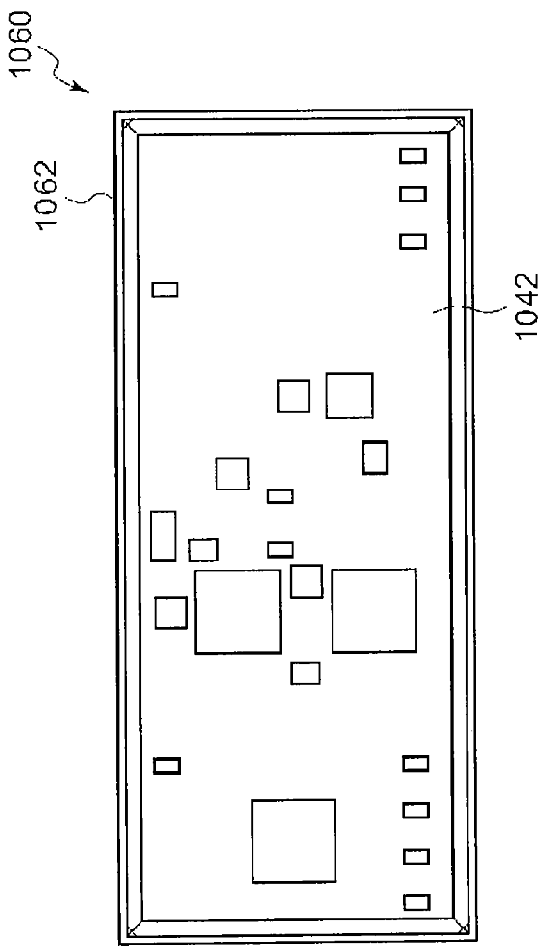


FIG.18C

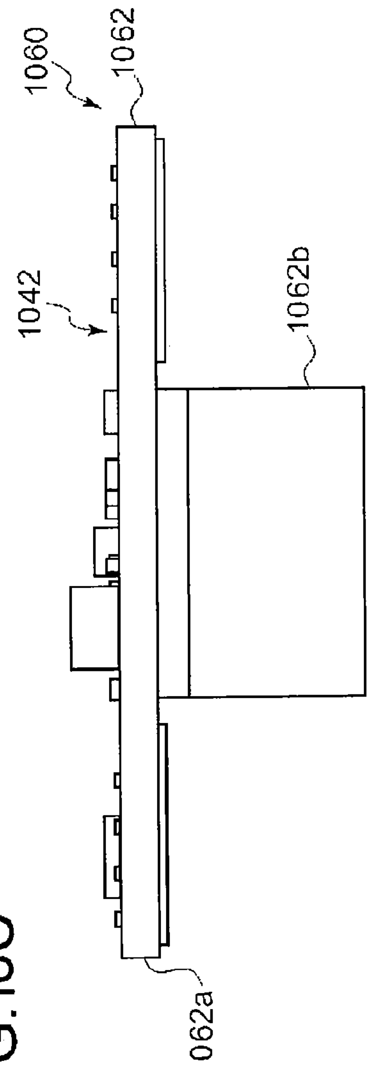


FIG.19

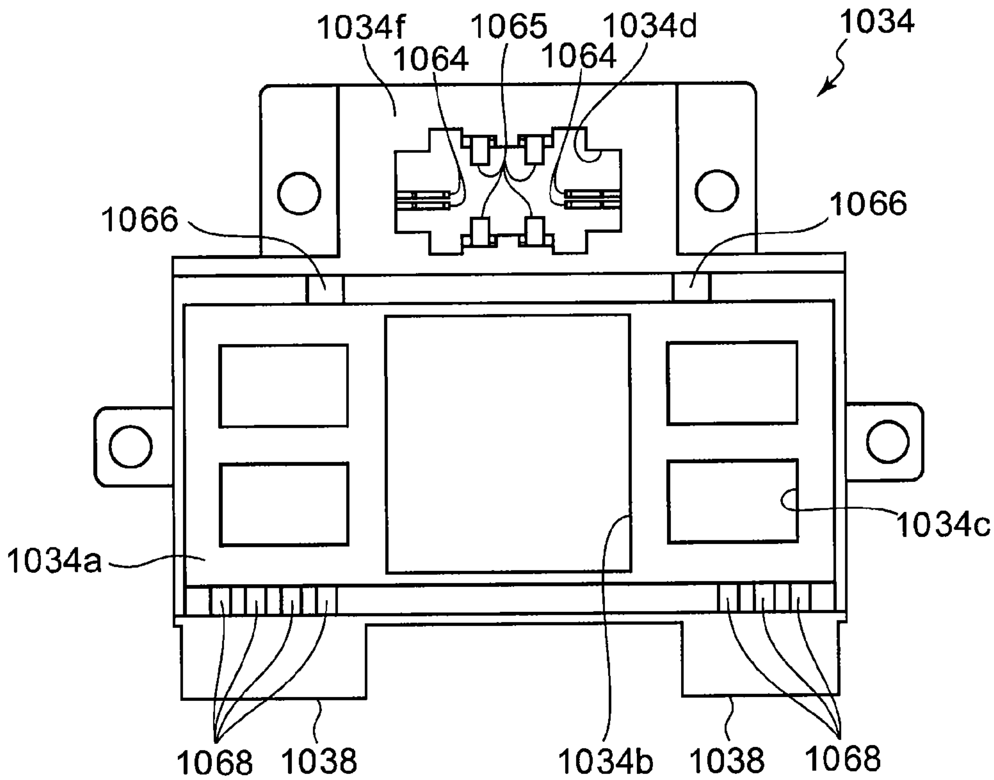

1034f
1065
1034d
1034
1064
1064
1066
1066
1034c
1034a
1068
1038
1034b
1038
1068

FIG.20

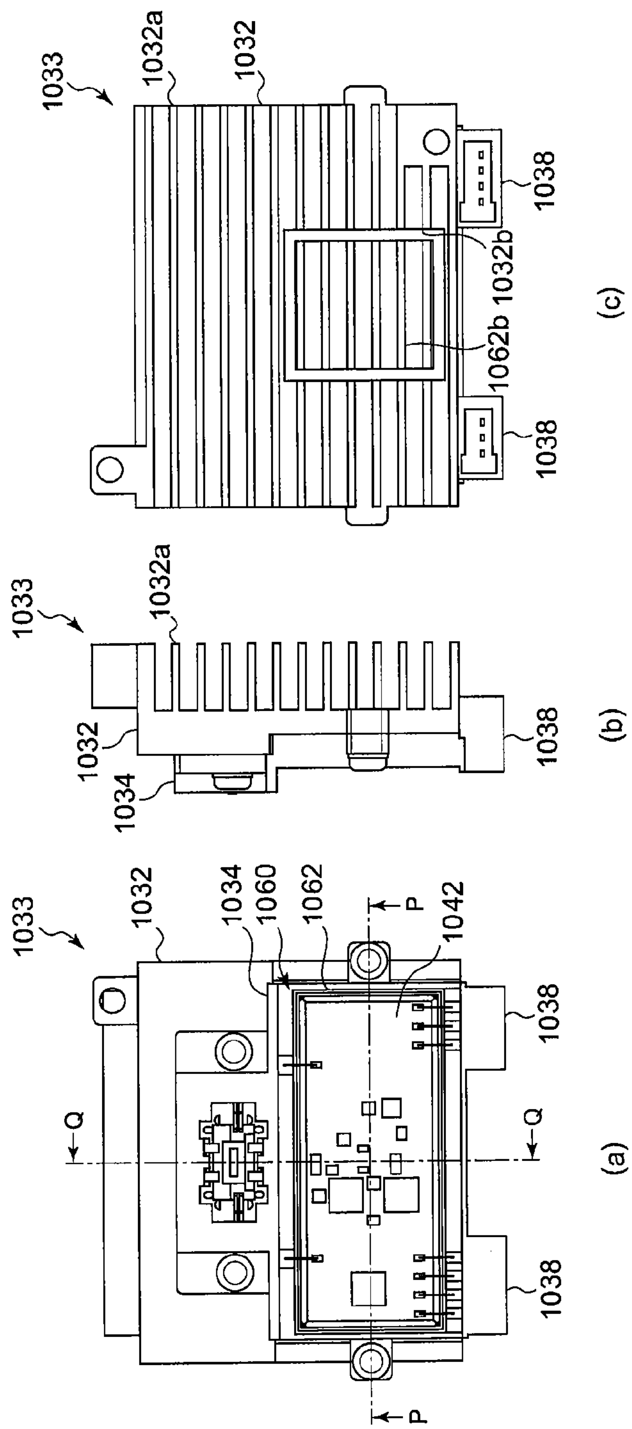
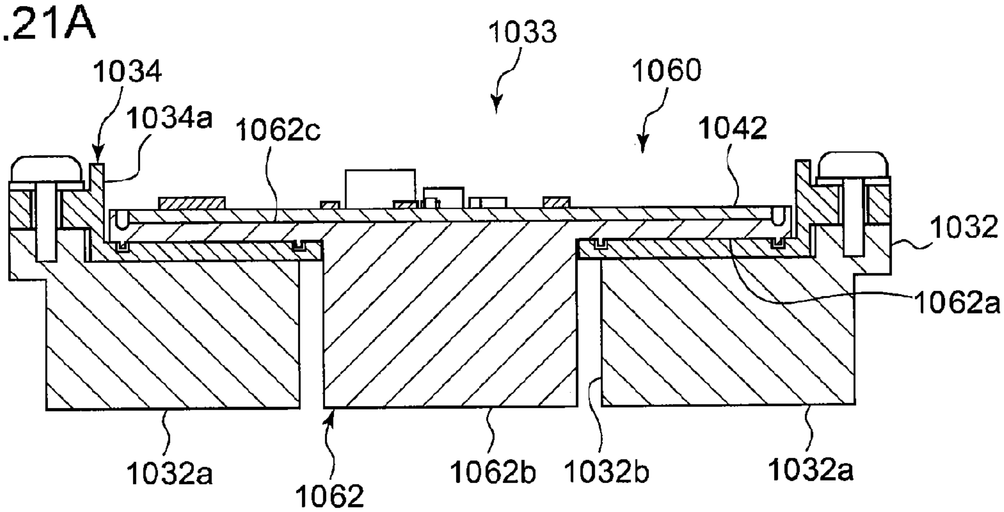
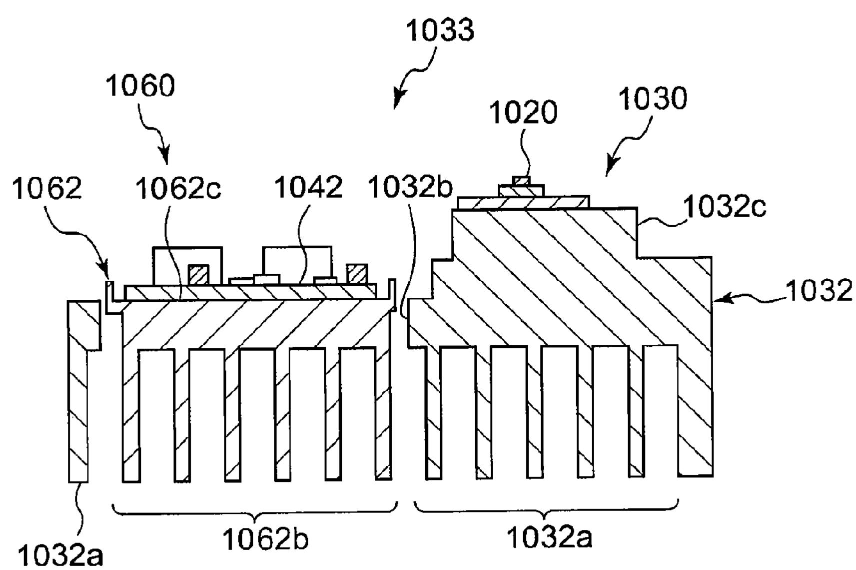


FIG.21A



P-P

FIG.21B



Q-Q

FIG.22

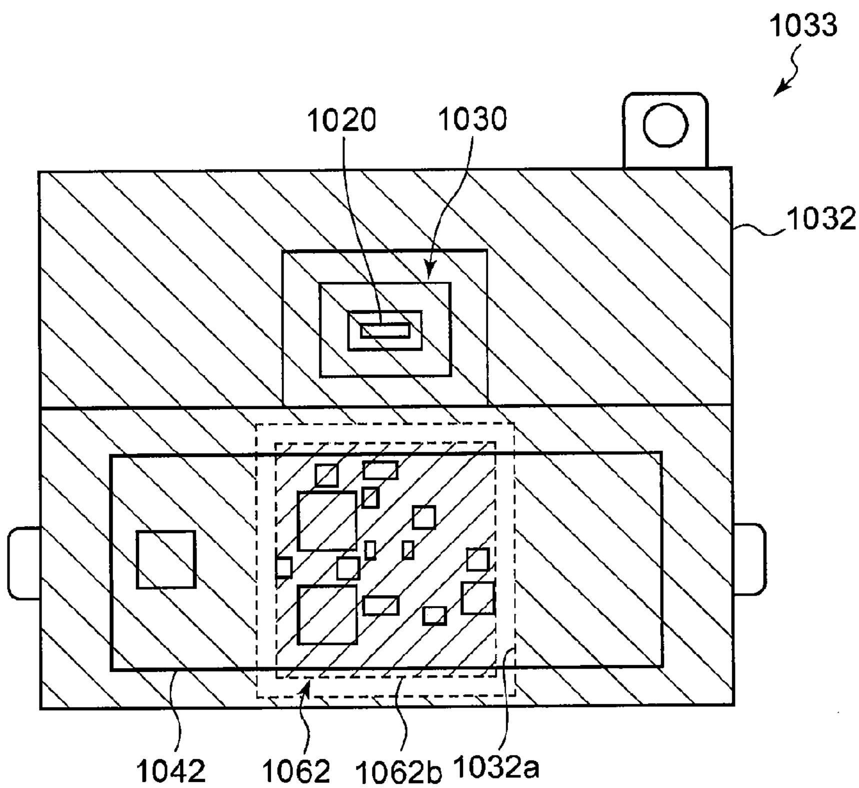
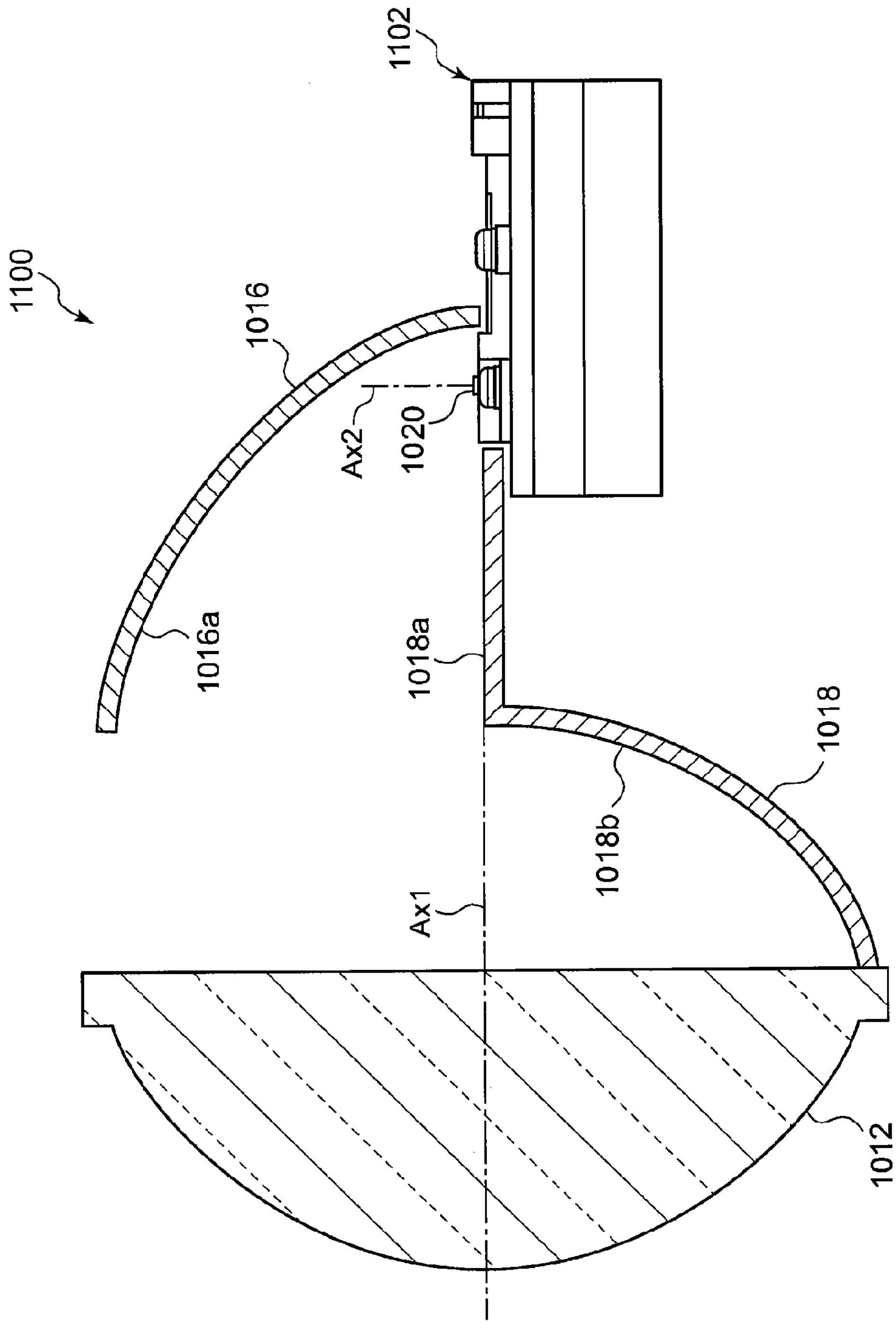


FIG.23



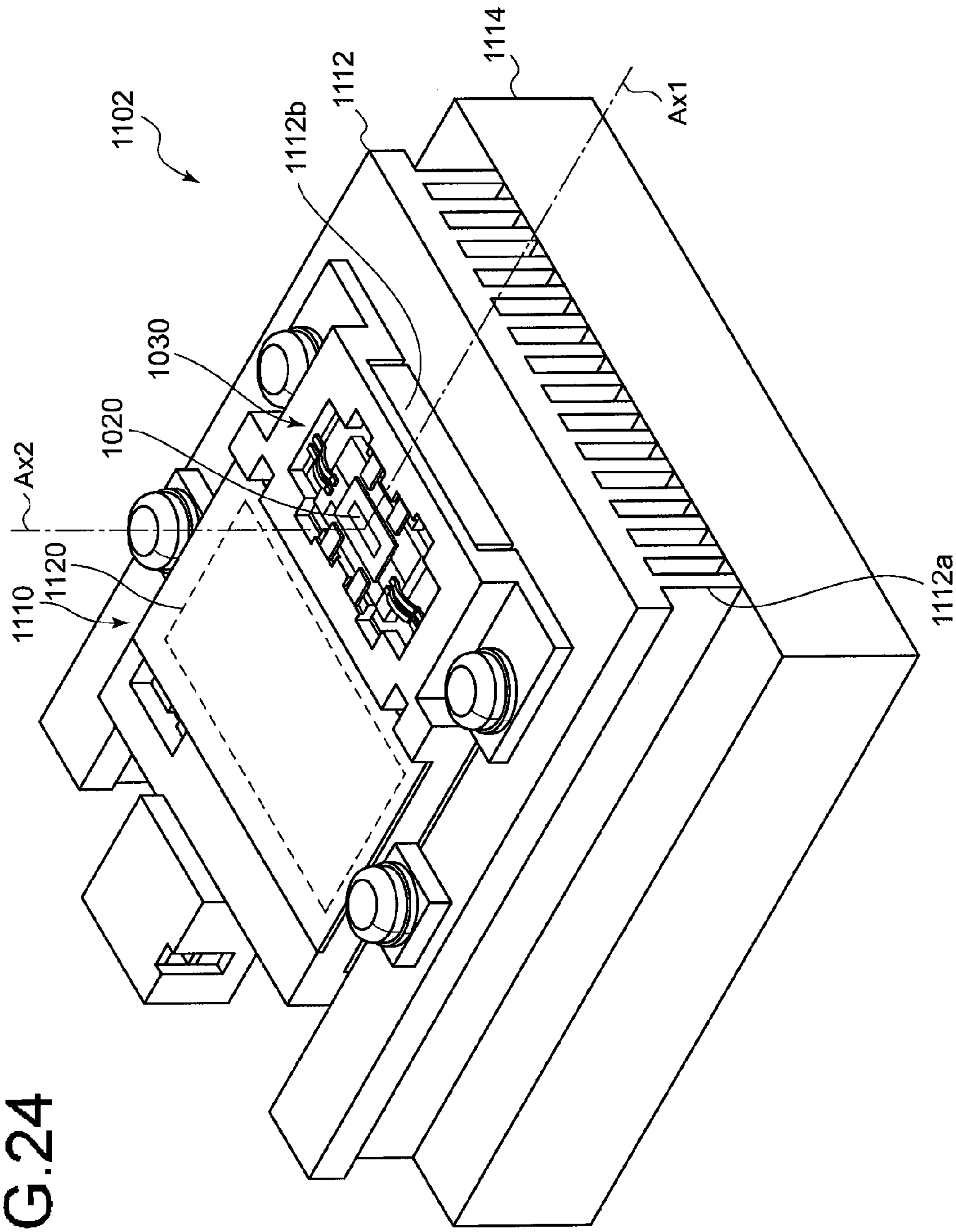
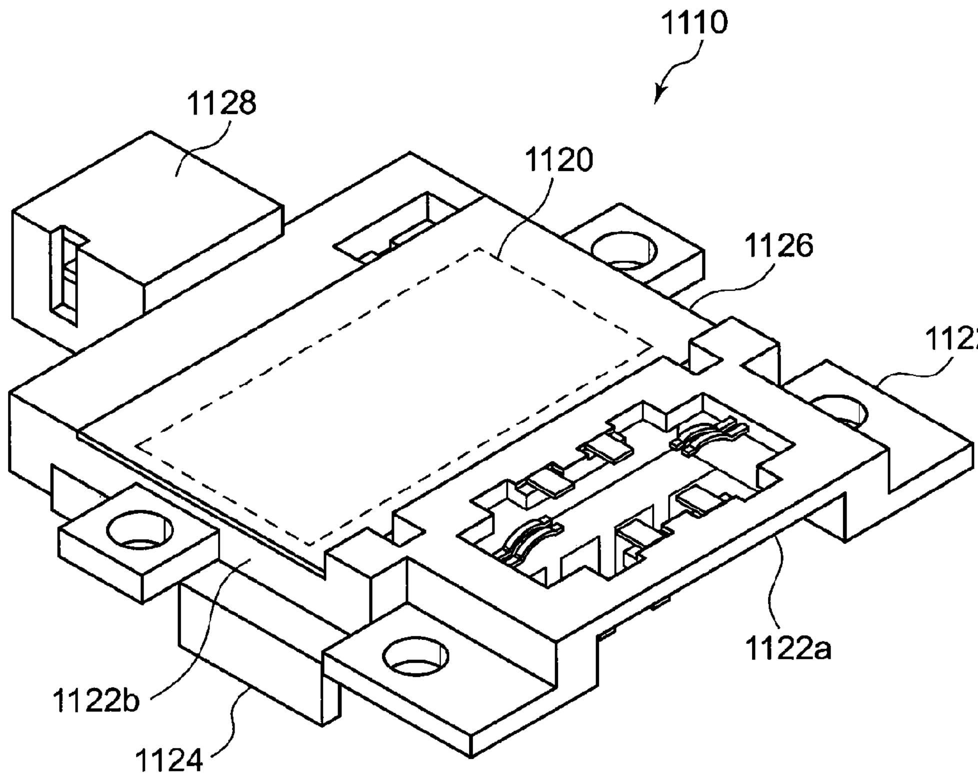


FIG.24

FIG.25



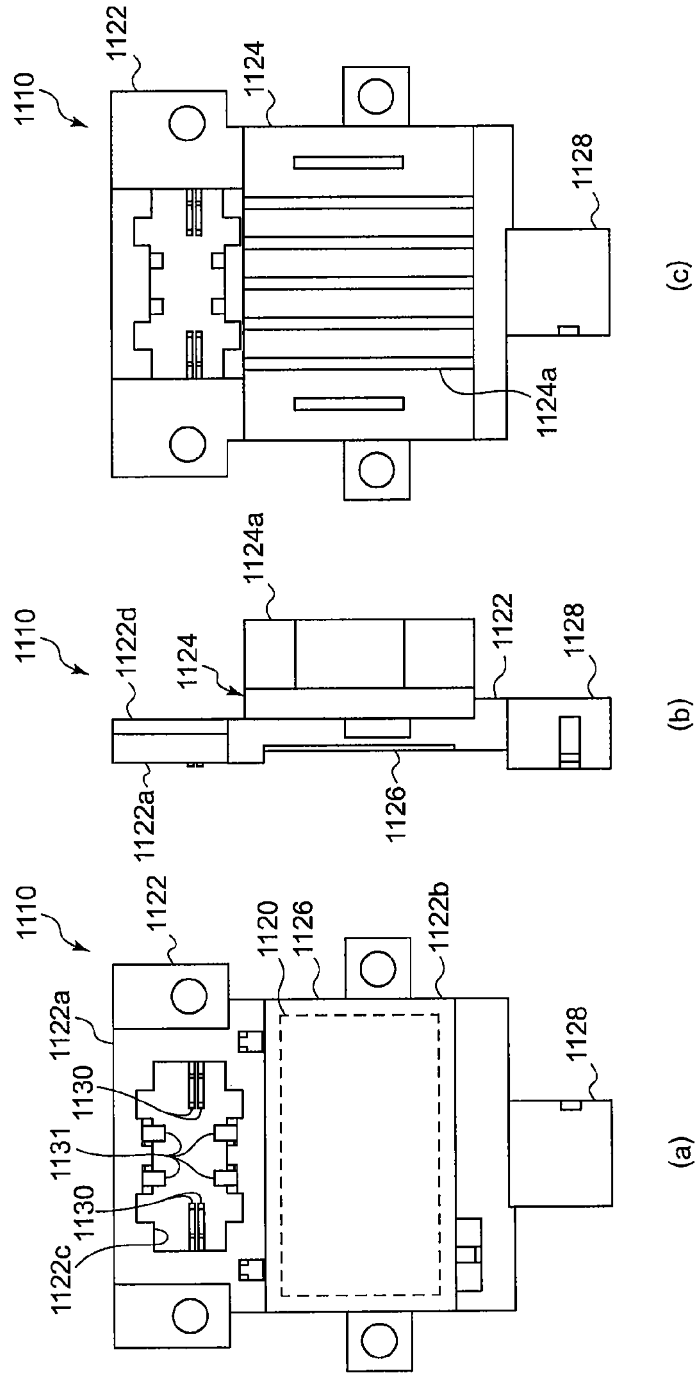

1110
1122
1124
1128
1124a
(c)
1110
1122d
1124
1124a
1122
1128
1122a
1126
(b)
1110
1122
1122a
1130
1131
1130
1122c
1120
1126
1122b
1128
(a)

FIG.26

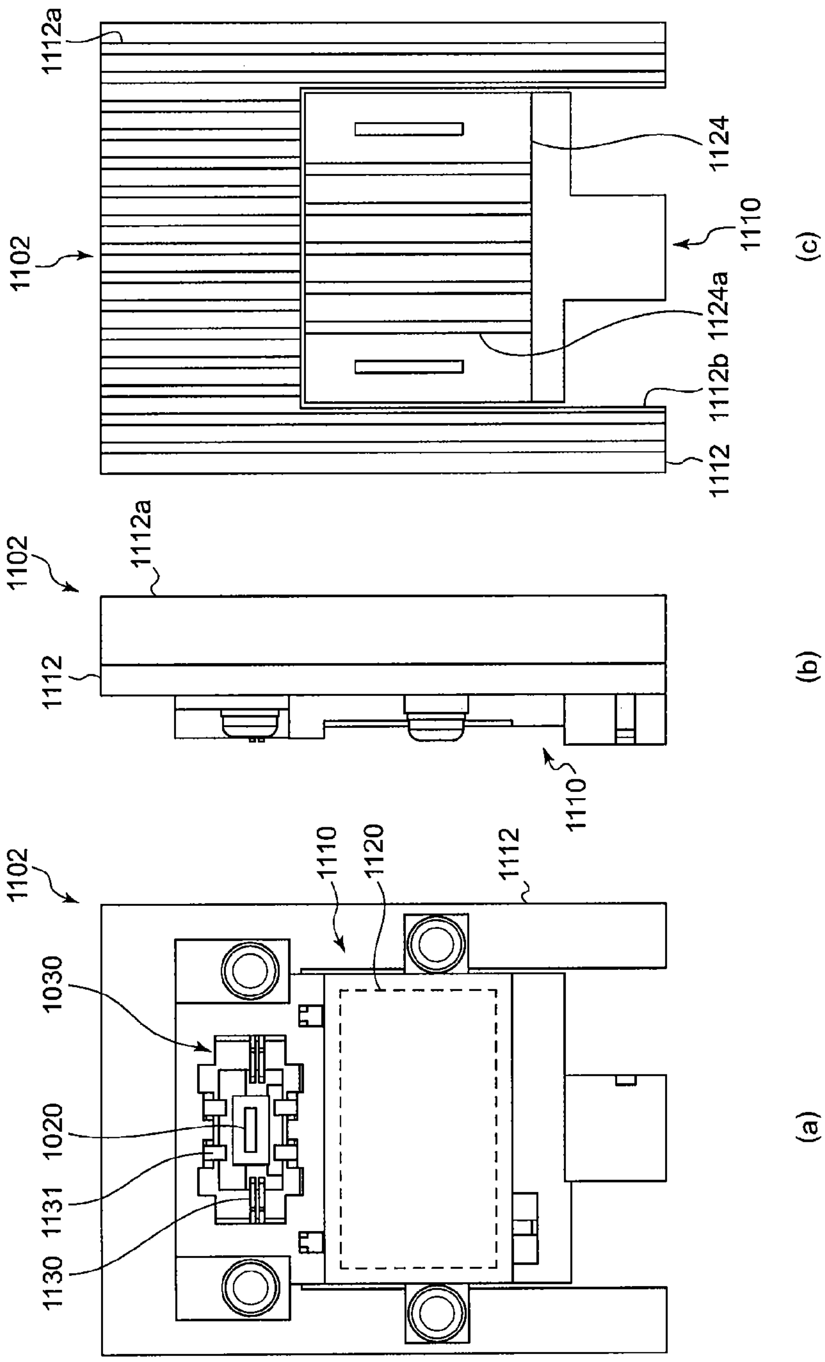

1102
1112a
1124
1110
1124a
1112b
1112
(c)
1102
1112a
1112
1110
(b)
1102
1030
1020
1131
1130
1110
1120
1112
(a)

FIG.27

AUTOMOTIVE HEADLAMP, HEAT RADIATING MECHANISM, LIGHT-EMITTING APPARATUS AND LIGHT SOURCE FIXING MEMBER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2011-131425, filed on Jun. 13, 2011, Japanese Patent Application No. 2011-143274, filed on Jun. 28, 2011, Japanese Patent Application No. 2011-146267, filed on Jun. 30, 2011, and Japanese Patent Application No. 2012-002289, filed on Jan. 10, 2012, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to an automotive headlamp, and more particularly to an automotive headlamp having a light-emitting module including a control circuit unit for controlling the lighting of a light source.

2. Description of the Related Art

There is a known technology for utilizing light-emitting elements, such as LEDs (Light Emitting Diodes), as the light source of an automotive headlamp. In such a technology as disclosed in Japanese Patent Application Publication No. 2005-32661, a light source apparatus is proposed in which at least one of the electrical coupling means coupling the light-emitting elements with the mounting substrate is so disposed as to pass across an area in the irradiation direction as seen from the light-emitting elements.

Recent years have seen the emergence of various applications that require complex lighting control for automotive headlamps. In such applications, a control circuit for controlling the lighting of the light-emitting elements is provided independently of the mounting substrate to which the light-emitting elements are directly mounted as in the case described above. However, there are growing demands for the space occupied by the automotive headlamps to be smaller because of the limited space within a vehicle. Thus, the location of this control circuit is an extremely important consideration from the viewpoint of reduction in the space occupied by the automotive headlamps.

SUMMARY OF THE INVENTION

The present invention has been made to solve the above-described problems, and a purpose thereof is to provide a technology for limiting the space to be occupied by automotive headlamps.

To resolve the foregoing problems, an automotive headlamp according to one embodiment of the present invention includes: a light-emitting module configured such that a light source and a control circuit unit for controlling the lighting of the light source are structured integrally with each other; and a reflector having a reflecting surface for reflecting light emitted from the light source and collecting the reflected light. The control circuit unit is disposed in a position anterior to the light source in a lamp unit.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments will now be described by way of examples only, with reference to the accompanying drawings which are meant to be exemplary, not limiting and wherein like elements are numbered alike in several Figures in which:

FIG. **1** shows a structure of an automotive headlamp according to a first embodiment of the present invention;

FIG. **2**A is a perspective view showing a structure of a light-emitting module according to a first embodiment;

FIG. **2**B is a side view of a light-emitting module according to the first embodiment;

FIG. **3** is a cross-sectional view showing a structure of a light-emitting module;

FIG. **4** is a perspective view showing a structure of a light-emitting module according to a second embodiment;

FIG. **5** is a perspective view showing a structure of a light-emitting module according to a third embodiment;

FIG. **6** shows a structure of an automotive headlamp according to a fourth embodiment;

FIG. **7**A is a perspective view showing a structure of a light-emitting module according to a fourth embodiment;

FIG. **7**B is a side view of a light-emitting module according to the fourth embodiment;

FIG. **8** is a rear perspective view showing a structure of an automotive headlamp according to a fifth embodiment;

FIG. **9** shows a state where a light-emitting module is inserted into a holding section of a support member;

FIG. **10** shows a state where a light-emitting module has been fixed to a securing section of a support member;

FIG. **11** shows a state where a fan-side connector is mounted on a connector unit;

FIG. **12** shows a heatsink according to a sixth embodiment;

FIG. **13** shows a heatsink according to a seventh embodiment;

FIG. **14** shows a structure of an automotive headlamp according to an eighth embodiment;

FIG. **15**A is a perspective view showing a structure of a light-emitting module according to an eighth embodiment;

FIG. **15**B is a side view of a light-emitting module according to the eighth embodiment;

FIG. **16** is a perspective view showing a method for assembling a light-emitting module according to an eighth embodiment;

FIG. **17** is a perspective view of an attachment unit according to an eighth embodiment;

FIG. **18**A is a top view of a circuit unit;

FIG. **18**B is a right side view of a circuit unit;

FIG. **18**C is a front view of a circuit unit;

FIG. **19** is a top view of an attachment;

FIG. **20**A is a top view of an attachment unit;

FIG. **20**B is a right side view of an attachment unit;

FIG. **20**C is a bottom view of an attachment unit;

FIG. **21**A is a cross-sectional view of FIG. **20**A taken along the line P-P;

FIG. **21**B is a cross-sectional view of FIG. **20**A taken along the line Q-Q;

FIG. **22** shows a region where heat radiation fins of a first heatsink are provided and a region where heat radiation fins of a second heatsink are provided, in the top view of the attachment unit;

FIG. **23** shows a structure of an automotive headlamp according to a ninth embodiment;

FIG. **24** is a perspective view of a light-emitting module according to a ninth embodiment;

FIG. **25** is a perspective view of an attachment unit according to a ninth embodiment;

FIG. **26**A is a front view of an attachment unit;

FIG. **26**B is a left side view of an attachment unit;

FIG. **26**C is a bottom view of an attachment unit;

FIG. **27**A is a front view of a light-emitting module;

FIG. **27**B is a left side view of a light-emitting module; and FIG. **27**C is a bottom view of a light-emitting module.

DETAILED DESCRIPTION OF THE INVENTION

The invention will now be described by reference to the preferred embodiments. This does not intend to limit the scope of the present invention, but to exemplify the invention.

An automotive headlamp according to first to ninth embodiments of the present invention includes a light-emitting module, in which a light source and a control circuit unit for controlling the lighting of the light source are structured integrally with each other, and a reflector having a reflecting surface for reflecting light emitted from the light source and focusing (collecting) the reflected light. The control circuit unit is disposed in a position anterior to the light source in a lamp unit.

In the automotive headlamp, optical components, such as a reflector, a shade and the like are normally disposed in positions anterior to the light source in the lamp unit. However, if the control circuit unit is located in a position posterior to the light source in the lamp unit to avoid the interference between such components and the control circuit unit, then the control circuit unit will protrude in the posterior direction from the light source, thus making it difficult to limit the space occupied by the automotive headlamp. According to the present embodiments, however, the control circuit unit can be located in a position anterior to the light source in the lamp unit, so that the protrusion of the control circuit unit in the posterior direction from the light source can be avoided. This configuration and arrangement prevent any increase in space to be occupied by the control circuit unit.

The control circuit unit in a position anterior to the light source in the lamp unit may be so located as to be clear of the path of light used to form a light distribution pattern of the light emitted by the light source.

Location of the control circuit unit anterior to the light source within the lamp unit can produce unwanted effects of its shadow or reflected light on the light distribution pattern. According to the present embodiment of the invention, the adverse effects on the light distribution pattern that may be caused by the arrangement where the control circuit unit is disposed anterior to the light source in the lamp unit can be avoided by locating the control circuit unit clear of the path of light to form the light distribution pattern.

The light-emitting module may further include a cover that covers at least a part of the control circuit unit. The cover may have a shade portion capable of forming a peripheral or edge part of the light distribution pattern by shielding a part of the light emitted from the light source.

According to this embodiment, the number of components can be made smaller than when the cover of the control circuit unit and the shade are provided separately. This also makes parts management easier.

The light source may be so disposed that its main optical axis is perpendicular to the optical axis of the lamp unit and the light-emitting portion thereof protrudes more in the direction of the main optical axis than the control circuit unit.

According to this embodiment, the main optical axis of the light source being perpendicular to the optical axis of the lamp unit makes it possible to form a light distribution pattern more effectively through the reflector. Also, the light-emitting portion protruding more in the direction of the main optical axis than the control circuit unit makes it possible to avoid the location of the control circuit unit in a front position anterior to the light-emitting portion in the lamp unit, and there will be no adverse effects on the light distribution pattern.

The light-emitting module may include a fixed connector that is so provided as to allow connection of a wire connector. The fixed connector may be disposed in a position anterior to the light source in the lamp unit and clear of the path of light such that the fixed connector allows connection of the wire connector which is brought closer to the path of light through an area clear of the path of light.

According to this embodiment, there will be least effects of its shadow or reflected light of the wire connector on the light distribution pattern. Also, the wire connector is so structured as to have a wire in the rear as the wire connector is brought to connect to the fixed connector. Hence, as the wire connector is brought to connect to the fixed connector in a direction approaching the path of light, the wire led out from the wire connector can be located further away from the path of light. The wire, which is flexible, may possibly deform and stray into the path of light once it is subjected to some external force. However, the location of the wire further apart from the path of light can minimize the possibilities of adverse effect of stray wire on the light distribution pattern.

A fan for cooling the light source may further be provided. The control circuit unit may further have a function of controlling the drive of the fan. The light-emitting module may have a fan connector for connecting the fan to the control circuit unit. According to this embodiment, it is no longer necessary to provide a control circuit unit for the fan separately from the control circuit unit for controlling the lighting of the light source. As a result, the space for locating an additional control circuit may be eliminated.

The light-emitting module may further have a single input connector through which a first control signal used to control the lighting of the light source and a second control signal used to control the drive of the fan are inputted. According to this embodiment, both the first control signal and the second control signal can be inputted by simply connecting another single connector capable of outputting the first control signal and second control signal to the single input connector. Thus, the number of processes required for assembly can be reduced from the case when the connector for the first control signal and the connector for the second control signal are provided separately.

A support member to support the reflector may be further provided. The support member may have a holding section into which the control circuit unit is inserted in an anterior direction of the lamp unit and a securing section that secures the light-emitting module abutting an anterior position in the lamp unit after the insertion of the control circuit unit. According to this embodiment, the light-emitting module may be attached to the support member by a simple process of securing it as it is inserted in an anterior direction of the lamp unit. This easy attachment and detachment of the light-emitting module makes assembly and maintenance easier, too.

Hereinbelow, the embodiments will now be described in detail with reference to drawings.

(First Embodiment)

FIG. **1** shows a structure of an automotive headlamp **10** according to a first embodiment of the present invention. FIG. **1** is a vertical cross-sectional view, of the automotive headlamp **10**, including an optical axis Ax**1** of a lamp unit. The automotive headlamp **10** functions as a so-called low-beam light source that forms a low-beam light distribution pattern. It should be noted that the automotive headlamp **10** is not limited to that described above and the automotive headlamp **10** may function as a high-beam light source that forms a high-beam light distribution pattern.

The automotive headlamp **10** includes a projection lens **12**, a light-emitting module **14**, a reflector **16**, and a shade **18**. The projection lens **12** is a plano-convex aspheric lens, having a convex front surface and a plane rear surface, which projects a light source image formed on a rear focal plane toward a front area of the lamp unit as a reverted image.

The light-emitting module **14** has a light-emitting element **20** constituted by LEDs, which are semiconductor light-emitting elements. It is to be noted that the light-emitting element **20** may be constituted by any other light-emitting elements than LEDs, and an electric-discharge lamp, an incandescent lamp, or the like may be used as the light source in the place of the light-emitting element **20**. The light-emitting module **14** is disposed such that the light-emitting element **20** emits light mainly upward.

The reflector **16** has a reflecting surface **16***a* that reflects and focuses the light emitted by the light-emitting element **20**. The reflector **16** is disposed such that the reflecting surface **16***a* is located above and opposite to the light-emitting element **20**. The shade **18** has a shade section **18***a* and a dummy section **18***b*. The shade section **18***a* has a plane containing the optical axis Ax**1** of the lamp unit, which defines a cutoff line near the horizontal line of the low-beam light distribution pattern. Note that a description of the shape of the shade section **18***a*, which is known in the art, is omitted. The dummy section **18***b* functions as a design-designated member which constitutes a design surface visible from the outside.

FIG. **2**A is a perspective view showing a structure of the light-emitting module **14** according to the first embodiment of the present invention. FIG. **2**B is a side view of the light-emitting module **14** according to the first embodiment. The light-emitting module **14** includes a package **30**, a heatsink **32**, an attachment **34**, a fan **36**, a cover **40**, and a control circuit unit **42**.

The package **30** includes a light-emitting element **20**. The control circuit unit **42** controls the lighting of the light-emitting element **20**. According to this embodiment, the control circuit unit **42** is configured by a printed-circuit board and electrical components and elements mounted on the printed-circuit board.

The heatsink **32** is made of a highly heat radiant material, such as aluminum. The heatsink **32** has heat radiation fins **32***a* that radiate heat generated by the light-emitting element **20** and the control circuit unit **42**. Also, the arrangement may be such that the heatsink **32** has a first heatsink for dissipating the heat from the light-emitting element **20** and a second heatsink for dissipating the heat from the control circuit unit **42**. The attachment **34** is mounted on the top face of the heatsink **32**, thereby installing the package **30** on the top face of the heatsink **32**.

The heat radiation fins **32***a* of the heatsink **32** are provided in a lower part of the heatsink **32**. The heat radiation fins **32***a* are provided in such a manner as to extend in a direction perpendicular to the optical axis Ax**1** of the lamp unit. The fan **36** is mounted to the heatsink **32** below the heat radiation fins **32***a* such that the fan **36** can blow air to the heat radiation fins **32***a*.

The attachment **34** has a fixed connector **38** integrally secured thereto by a resin integral molding. The fixed connector **38** is so provided as to allow connection of a wire connector. The attachment **34** also has a circuit holding section which is a downward recess to hold the control circuit unit **42**. The control circuit unit **42** is held in this circuit holding section. After the control circuit unit **42** is placed therein, the cover **40** is attached to the attachment **34**. It is also to be noted that the cover **40** may be excluded. Also, in the place of the cover **40**, the arrangement may be such that a resin molding is applied to the circuit holding section after the placement of the control circuit unit **42** therein.

The control circuit unit **42** is such that the length thereof in the direction perpendicular to the optical axis Ax**1** of the lamp unit is greater than the length thereof in the direction parallel thereto. More specifically, the length thereof in the direction perpendicular to the optical axis Ax**1** of the lamp unit is more than twice that in the direction parallel thereto. Provision of the control circuit unit **42** in this manner can reduce the length of the light-emitting module **14** in the direction of the optical axis Ax**1** of the lamp unit, thus contributing to the further downsizing of the automotive headlamp **10**.

The attachment **34**, the control circuit unit **42**, and the cover **40** constitute an attachment unit **33**. In the first embodiment, the control circuit unit **42** and the cover **40** are installed in advance on the attachment **34** before the attachment **34** is mounted on the heatsink **32**, and the control circuit unit **42** and the cover **40** are mounted on the heatsink **32** as the attachment unit **33**. As a result, the attachment **34** and the control circuit unit **42** are mounted integrally on the heatsink **32**, and at the same time the package **30** is installed in such a manner as to be held between the attachment **34** and the heatsink **32**.

As described above, the light-emitting module **14** has the light-emitting element **20** as the light source and the control circuit unit **42** controlling the lighting of the light-emitting element **20** integrally structured together. Thus incorporation of the light-emitting module **14** into the automotive headlamp **10** realizes a simultaneous installation of the light-emitting element **20** and the control circuit unit **42** in the automotive headlamp **10**. This will reduce the number of processes required for the assembly of the automotive headlamp **10**.

FIG. **3** is a cross-sectional view showing a structure of the light-emitting module **14**. FIG. **3** represents a cross section of the light-emitting module **14** in a plane containing both the optical axis Ax**1** of the lamp unit and a main optical axis Ax**2**. Note that the main optical axis Ax**2**, as used herein, is the axis passing through the center of the main light-emitting surface, which is the top surface of the light-emitting element **20**, perpendicularly thereto.

The package **30** includes a light-emitting element **20**, a submounting board **50**, and a mounting board **52**. The light-emitting element **20** is mounted to the submounting board **50**, and the submounting board **50** is mounted to the mounting board **52**. The mounting board **52** is provided with a conductive member (not shown) for power feeding.

The attachment **34** has a conductive member **54** integrally molded therewith. The conductive member **54** is connected to the control circuit unit **42** by wire bonding or the like. As the attachment **34** is mounted on the heatsink **32**, the conductive member **54** comes in contact with the above-mentioned conductive member of the mounting board **52**, thereby establishing an electrical continuity between the package **30** and the control circuit unit **42**. Thus the package **30** and the control circuit unit **42** can be electrically connected to each other quite easily.

The control circuit unit **42** is disposed in a position anterior to the light-emitting element **20** in the lamp unit. In this setting, the control circuit unit **42** in a position anterior to the light-emitting element **20** in the lamp unit is so disposed as to be clear of the path of light used to form a light distribution pattern in all the light emitted by the light-emitting element **20**. More specifically, the control circuit unit **42** is located in a position anterior to the package **30** and below the cover **40** in the lamp unit. The path of light used to form a light distribution pattern is further above the shade section **18***a* of the shade **18** which is placed on the cover **40**. Therefore, the control circuit unit **42**, which is disposed below the cover **40**, is located in a region clear of the path of light used to form a light distribution pattern.

The light-emitting module **14** is disposed such that the main optical axis Ax**2** of the light-emitting element **20** is oriented vertically upward. Therefore, the light-emitting module **14** is so oriented that the main optical axis Ax**2** of the light-emitting element **20** is perpendicular to the optical axis Ax**1** of the automotive headlamp **10**. As such, the light can be efficiently cast on the reflector **16**. Accordingly, a low-beam light distribution pattern can be formed properly by way of the reflector **16**.

Also, the light-emitting element **20** is so disposed that a light-emitting portion thereof protrudes higher than the control circuit unit **42** in the direction of the main optical axis Ax**2**. The light-emitting portion includes the main light-emitting surface of the light-emitting element **20** and the side portions surrounding the main light-emitting surface. This avoids the location of the control circuit unit **42** in a front position anterior to the light-emitting portion in the lamp unit, thus ridding of the adverse effects on the light distribution pattern of the control circuit unit **42** located in a front position within the lamp unit.

The cover **40** is provided to cover the whole opening above the circuit holding section in order to prevent foreign material from entering the control circuit unit **42**. Thus, the cover **40** is so provided as to cover the entirety of the control circuit unit **42**. However, the arrangement may be such that the cover **40** covers only a part of the control circuit unit **42**.

The shade section **18***a* of the shade **18** is located above the cover **40**. Hence, the cover **40** is disposed on a level lower than the position of the light-emitting element **20**, so that the top surface of the cover **40** is below the optical axis Ax**1** of the lamp unit. In this manner, the light-emitting portion of the light-emitting element **20** is located in a position higher than the control circuit unit **42** and the cover **40**, and therefore the heatsink **32** has a portion to hold the package **30** protruding higher than the portion to hold the control circuit unit **42**.

In the area anterior to the light-emitting element **20** in the lamp unit, the region above the shade section **18***a* serves as the path of light to form a low-beam distribution pattern. In the first embodiment, the control circuit unit **42** and the fixed connector **38** are located lower than the top surface of the shade section **18***a* in order for the control circuit unit **42** and the fixed connector **38** to be clear of the path of light in the area anterior to the light-emitting element **20** in the lamp unit. As a result, any adverse effects of the shadow and reflected light of the control circuit unit **42** or the fixed connector **38** on the low-beam distribution pattern can be eliminated.

Also, the fixed connector **38** has a connection part for connection of the wire connector **58** in a lower portion thereof to facilitate the connection of the wire connector **58** by moving the wire connector **58** vertically upward in a region clear of the path of light. It should be appreciated, however, that the direction of connection of the wire connector **58** is not limited to the one described above. The wire connector **58** may be connected by moving the wire connector **58** in any other directions approaching the path of light in a region clear of the path of light.

The wire connector **58** is of such structure that a wire is led out from an end thereof opposite to the end to be connected to the fixed connector **38**. Accordingly, the wire connector **58** is connected to the fixed connector **38** as the wire connector **58** is moved vertically upward. This allows the wire led out from the wire connector **58** to be located further away from the path of light, thereby minimizing the possibilities of the wire deforming and straying upward causing any adverse effect on the light distribution pattern.

(Second Embodiment)

FIG. **4** is a perspective view showing a structure of a light-emitting module **100** according to a second embodiment. The structure of an automotive headlamp according to the second embodiment is the same as that of the automotive headlamp **10** according to the first embodiment except that the light-emitting module **100** is provided in the place of the light-emitting module **14**. Note that the same components as those in the first embodiment are hereinbelow denoted with the same reference numerals as those therein, and the description thereof will be omitted.

The light-emitting module **100** is configured similarly to the light-emitting module **14** of the first embodiment except that an attachment **102** is provided in the place of the attachment **34**. The attachment **102** is configured similarly to the attachment **34** except that a fixed connector **104** is provided in the place of the fixed connector **38**. Thus the attachment **102**, the control circuit unit **42**, and the cover **40** constitute an attachment unit **101**, and this attachment unit **101** is mounted on the heatsink **32**.

The fixed connector **104** is provided on each of the left and right side surfaces of the attachment **102**. The fixed connector **104** has a connection part for connection of the wire connector in a lower portion thereof to facilitate the connection of the wire connector by moving the wire connector vertically upward in a region lower than the top surface of the shade section **18***a*. Thereby, the wire connector can be clear of the path of light when the wire connector is brought to connect to the fixed connector **104**. It should be appreciated, however, that the direction of connection of the wire connector is not limited to the one described above. The wire connector may be connected by moving the wire connector in any other directions approaching the path of light in a region clear of the path of light. Provision of the fixed connectors **104** on the side surfaces of the attachment **102** can further reduce the length of the light-emitting module **100** in the direction of the optical axis Ax**1** of the lamp unit.

(Third Embodiment)

FIG. **5** is a perspective view showing a structure of a light-emitting module **150** according to a third embodiment. The structure of an automotive headlamp according to the third embodiment is the same as that of the automotive headlamp **10** according to the first embodiment except that the light-emitting module **150** is provided in the place of the light-emitting module **14**. Note that the same components as those in the above-described embodiments are hereinbelow denoted with the same reference numerals as those therein, and the description thereof will be omitted.

The light-emitting module **150** is configured similarly to the light-emitting module **14** of the first embodiment except that an attachment **152** is provided in the place of the attachment **34**. The attachment **152** is configured similarly to the attachment **34** except that a fixed connector **154** is provided in the place of the fixed connector **38**. Thus the attachment **152**, the control circuit unit **42**, and the cover **40** constitute an attachment unit **151**, and this attachment unit **151** is mounted on the heatsink **32**.

The two fixed connectors **154** are provided on a side surface, which is located rearward in the lamp unit, of the attachment **152**. The fixed connector **154** has a connection part for connection of the wire connector in a rearward position in the lamp unit. This connection part in the fixed connector **154** is so provided as to facilitate the connection of the wire connector by moving the wire connector horizontally toward a front area in the lamp unit in a region posterior to the light-emitting element **20** in the lamp unit in order that the wire connector can be clear of the path of light. It should be appreciated, however, that the direction of connection of the wire connector is not limited to the one described above. Provision, in this manner, of not only the control circuit unit **42** in a position anterior to the light-emitting element **20** in the lamp unit but also the fixed connectors **154** on a rear side surface of the attachment **152** can reduce the length of the light-emitting module **150** in the direction of the optical axis Ax**1** of the lamp unit. At the same time, the provision thereof achieves a configuration that makes the connection of the wire connector to the fixed connector **154** easier.

(Fourth Embodiment)

FIG. **6** shows a structure of an automotive headlamp **200** according to a fourth embodiment. FIG. **6** is a vertical cross-sectional view, of the automotive headlamp **200**, including the optical axis Ax**1** of the lamp unit. The structure of an automotive headlamp according to the fourth embodiment is the same as that of the automotive headlamp **10** according to the first embodiment except that the light-emitting module **202** is provided in the place of the light-emitting module **14** and that a dummy member **204** is provided in the place of the shade **18**. Note that the same components as those in the above-described embodiments are hereinbelow denoted with the same reference numerals as those therein, and the description thereof will be omitted.

The dummy member **204** is formed in a shape such that the shade section **18***a* is removed from the shade **18** according to the first embodiment, and the dummy member **204** functions as a design-designated member which constitutes a design surface visible from the outside. A light-emitting module **202** is located in a position posterior to the dummy member **204** in the lamp unit.

FIG. **7**A is a perspective view showing a structure of the light-emitting module **202** according to the fourth embodiment. FIG. **7**B is a side view of the light-emitting module **202** according to the fourth embodiment. The light-emitting module **202** is configured similarly to the light-emitting module **14** of the first embodiment except that a heatsink **210**, an attachment **212**, and a cover **214** are provided in the place of the heatsink **32**, the attachment **34**, and the cover **40**, respectively.

The heatsink **210** has a portion to hold the package **30** protruding higher than the portion to hold the control circuit unit **42**. The level difference between the portion to hold package **30** and the portion to hold the control circuit unit **42** is smaller than that therebetween in the heatsink of the first embodiment.

The attachment **212** has a circuit holding section which is a downward recess to hold the control circuit unit **42**. The control circuit unit **42** is held in this circuit holding section. After the control circuit unit **42** is placed therein, the cover **214** is attached to the attachment **212**. The cover **214** covers the entire upper side of the control circuit unit **42**. Note that the cover **214** may be so provided as to cover at least part of the control circuit unit **42**.

The cover **214** has a shade portion **214***a* capable of forming a peripheral or edge part of the light distribution pattern by shielding a part of the light emitted by the light-emitting element **20**. In other words, the cover **214** has both the function of preventing foreign material from entering the control circuit unit **42** and the function of defining a cutoff line that is the peripheral part of the low-beam light distribution pattern. As a result, the number of components can be made smaller than when the cover of the control circuit unit and the shade are provided separately. This also makes parts management easier.

(Fifth Embodiment)

FIG. **8** is a rear perspective view showing a structure of an automotive headlamp **300** according to a fifth embodiment. Note that the same components as those in the above-described embodiments are hereinbelow denoted with the same reference numerals as those therein, and the description thereof will be omitted. The automotive headlamp **300** has a main body unit **302**. A light-emitting module and the above-described projection lens **12** (not shown) are mounted on the main body unit **302**.

The main body unit **302** has a reflector **16**, a lens holder **306**, and a support member **308**. The lens holder **306**, which is formed in a ring shape, is fixed in a manner such that projection lens **12** is fit into the lens holder **306**. The reflector **16** is fixed to the upper surface of the lens holder **306** and is supported by the support member **308**.

The support member **308** is comprised of a securing section **308***a*, a holding section **308***b*, an intake opening **308***c*, and an exhaust duct **308***d*. The control circuit unit for controlling the lighting of the light-emitting element is held within the holding section **308***b* by inserting the control circuit unit into the holding section **308***b*. The light-emitting module is fixed in a manner such that the light-emitting module is abutted against the securing section **308***a* after insertion of the control circuit unit. The intake opening **308***c* is an air inlet of a fan that cools the light-emitting element. In the fifth embodiment, too, the fan blows air to the heatsink, located above the fan, by drawing in air from below. Thus, the intake opening **308***c* is located below the holding section **308***b*. The exhaust duct **308***d* is an exhaust hole of the fan.

FIG. **9** shows a state where a light-emitting module **320** is inserted into the holding section **308***b* of the support member **308**. The light-emitting module **320** includes a package **30**, a control circuit unit **42**, a heatsink **322**, a connector unit **326**, and a fan **36**.

The heatsink **322** is made of a highly heat radiant material, such as aluminum. The package **30** is mounted on the top face of the heatsink **322**. The heatsink **322** has heat radiation fins that radiate heat generated by the light-emitting element **20** and the control circuit unit **42** of the package **30**. The heat radiation fins are provided in a lower part of the heatsink **322**. The heat radiation fins are provided in such a manner as to extend in a direction parallel to the optical axis of the lamp unit. The fan **36** is mounted to the heatsink **322** below the heat radiation fins such that the fan **36** can blow air to the heat radiation fins.

In the fifth embodiment, too, the control circuit unit **42** is disposed in a position anterior to the light-emitting element **20** in the lamp unit. For the automotive headlamps mounted on a vehicle, however, it is generally required that the light-emitting module **320** be insertable and removable from a rear area of the lamp unit. Accordingly, in the fifth embodiment, the control circuit unit **42** for controlling the lighting of the light-emitting element is held into the holding section **308***b* by inserting the control circuit unit **42** in an anterior direction of the lamp unit. Thus, the light-emitting module **320** can be attached and detached from the rear area of the lamp.

FIG. **10** shows a state where the light-emitting module **320** has been fixed to the securing section **308***a* of the support member **308**. The light-emitting module **320** is fixed to the securing section **308***a* in a manner such that the light-emitting module **320** abuts an anterior position in the lamp unit after the insertion of the control circuit unit **42** into the holding section **308***b*. More specifically, the light-emitting module

320 has a protrusion 328 protruding laterally therefrom. The protrusion 328 has a round hole. Also, the securing section 308*a* has screw holes. As the protrusion 328 is abutted against the securing section 308*a*, a screw 330 is screwed into the screw hole of the securing section 308*a* passing through the round hole of the protrusion 328. Thereby, the light-emitting module 320 is fixed firmly to the support member 308. Note that any other fastening means may be used in substitution for the screw 330.

As described above, both the direction in which the control circuit unit 42 is inserted and the butting direction at the time of securing the control circuit unit 42 are set to an anterior direction of the lamp unit. Hence, a simple process in which the light-emitting module 320 is moved forward and then secured with the screws 330 when it butts the securing section 308*a* enables the light-emitting module 320 to be secured to the support member 308.

It should be noted that the abutting direction of the light-emitting module 320 is not limited to the anterior direction of the lamp unit. For example, the light-emitting module 320 may be secured by abutting the light emitting module 320 against a position lower than the support member 308. In this case, for example, the light-emitting module 320 can be secured to the support member 308 with screws from above, for instance.

FIG. 11 shows a state where a fan-side connector 332 is mounted on the connector unit 326. The connector unit 326 has a fan connector 326*a* for use with fan and an input connector 326*b*. The fan connector 326*a* connects the fan 36 to the control circuit unit 42 by connecting the fan-side connector 332, connected to the fan 36, to the fan connector 326*a*. In the fifth embodiment, the control circuit unit 42 has a function of not only controlling the lighting of the light-emitting element 20 but also controlling the drive of the fan 36. As a result, the space for locating the circuit may be reduced as compared with the case where a drive circuit for driving the fan 36 is separately provided.

The vehicle is also provided with an electronic control unit (hereinafter referred to as "ECU") for controlling the lighting of the light-emitting element 20 and the drive of the fan 36. A single output connector for outputting a first control signal used to control the lighting of the light-emitting element 20 and a second control signal used to control the drive of the fan 36 extends from the ECU. This output connector is connected to the input connector 326*b*. Thus, the first control signal and the second control signal are inputted to the input connector 326*b* via the single connector. As a result, the number of connectors used may be reduced as compared with the case where provided are a first connector for the first control signal and a second connector for the second control signal.

(Sixth Embodiment)

FIG. 12 shows a heatsink 400 according to a sixth embodiment. An automotive headlamp according to the sixth embodiment is configured similarly to the automotive headlamps according to the above-described embodiments except that the heatsink 400 is used in the place of the above-described heatsinks.

The heatsink 400 is made of a highly heat radiant material, such as aluminum. The heatsink 400 has heat radiation fins 400*a* that radiate heat generated by the light-emitting element 20 of the package 30 and the control circuit unit 42. The heat radiation fins 400*a* are provided on one surface of a plate 400*b* in a rectangular form. In the sixth embodiment, the heat radiation fins 400*a* are placed in a plurality of portions demarcated by two lines out of a plurality of lines radiated from axis A of the fan 36, respectively, and extend perpendicular to the lines that demarcate the respective particular portions in the plurality of portions.

In the example of FIG. 12, the axis A of the fan 36 is located in the center of the plate 400*b*. The plate 400*b* is demarcated by four lines L1 to L4, which radiate from the axis A, into four portions P1 to P4. As shown in FIG. 12, the lines L1 to L4 extend from the axis A in such a manner that they are perpendicular to each other. The portion P1 is demarcated by the lines L1 and L2 into a rectangular. The portion P2 is demarcated by the lines L2 and L3 into a rectangular. The portion P3 is demarcated by the lines L3 and L4 into a rectangular. The portion P4 is demarcated by the lines L4 and L1 into a rectangular.

The heat radiation fins 400*a* in the portion P1 extend perpendicular to the line L1. The heat radiation fins 400*a* in the portion P2 extend perpendicular to the line L2. The heat radiation fins 400*a* in the portion P3 extend perpendicular to the line L3. The heat radiation fins 400*a* in the portion P4 extend perpendicular to the line L4. In this manner, the heat radiation fins 400*a* in each of the portions P1 to P4 are formed such that the heat radiation fins 400*a* extend perpendicular to each particular line demarcating each portion. The inventors of the present invention found out through their diligent research-and-development activities that such a configuration employed herein has a higher heat release effect than the configuration where the heat radiation fins extend in a single direction, for example. Hence, use of the heatsink 400 according to the sixth embodiment can suitably and efficiently radiate the heat generated by the light-emitting element 20 and/or the control circuit unit 42.

(Seventh Embodiment)

FIG. 13 shows a heatsink 500 according to a seventh embodiment. An automotive headlamp according to the seventh embodiment is configured similarly to the automotive headlamps according to the above-described embodiments except that the heatsink 500 is used in the place of the above-described heatsinks.

The heatsink 500 is made of a highly heat radiant material, such as aluminum. The heatsink 500 has heat radiation fins 500*a* that radiate heat generated by the light-emitting element 20 of the package 30 and the control circuit unit 42. The heat radiation fins 500*a* are provided on one surface of a plate 500*b* in a rectangular form.

The heatsink 500 is formed in a rod-like shape extending perpendicularly to one surface of the plate 500*b*. The heat radiation fins 500*a* are arranged such that a plurality of gaps (spacing) are formed in a plurality of directions. In the seventh embodiment, the heat radiation fins 500*a* are arranged such that the plurality of gaps is formed in both the vertical direction and the horizontal direction. If, for example, the heat radiation fins are so formed as to extend in one direction, the gaps between the heat radiation fins will also be formed in one direction only. In contrast to this, if, as described above, the heat radiation fins 500*a* are so formed that a plurality of gaps are formed in a plurality of directions, the flow of air around the heat radiation fins 500*a* can be made smooth. The inventors of the present invention also found out through their diligent research-and-development activities that the configuration, where the heat radiation fins 500*a* are formed as above has a higher heat release effect than the configuration, where the heat radiation fins extend in a single direction, for example. Hence, use of the heatsink 500 according to the seventh embodiment can suitably and efficiently radiate the heat generated by the light-emitting element 20 and/or the control circuit unit 42.

(Eighth Embodiment)

An eighth embodiment relates to a heat radiation mechanism and a light-emitting apparatus and, in particular, to a heat radiation mechanism for radiating the heat generated by a light source and a control circuit board for controlling the lighting of the light source and a light-emitting apparatus equipped with said heat radiation mechanism.

In the automotive headlamps being used, for example, there are cases where a control circuit for controlling the lighting of the light-emitting elements is provided independently of the mounting substrate to which the light-emitting elements are directly mounted. Since this control circuit provided separately also generates heat, the heat generated thereby needs to be radiated. Heat generated by the light-emitting elements such as LEDs needs to be radiated as well. Besides, if, for example, a heat-dissipating member for the control circuit and that for the light-emitting element are provided in different positions, it will be difficult to reduce the space occupied by these heat-dissipating members. Hence, it is a pressing need to reduce the space occupied by these heat-dissipating members in attempting to downsize the automotive headlamps.

The eighth embodiment is implemented to solve the aforementioned problems, and a purpose thereof is to place a heat-dissipating member for radiating the heat of the light source and a heat-dissipating member for radiating the heat generated by a control circuit for controlling the lighting of the light source in such a manner as to effectively use a limited space.

To resolve the foregoing problems, a heat radiation mechanism according to the eighth embodiment includes a first heat radiation member for radiating heat of a light source and a second heat radiation member for radiating heat generated by a control circuit board that controls the lighting of the light source, the second heat radiation member being placed such that the second heat radiation member overlaps with at least part of the first heat radiation member as viewed from a first direction parallel to the control circuit board. The first heat radiation member is placed such that the first heat radiation member overlaps with at least part of the control circuit board as viewed from a second direction perpendicular to the control circuit board.

According to this embodiment, the first heat radiation member and the second heat radiation member are so arranged that they overlap with each other as viewed from the first direction. Thus, the area of the space occupied by the first heat radiation member and the second radiation member as viewed from the first direction can be reduced. Also, the first heat radiation member is so arranged that the first heat radiation member overlaps with at least part of the control circuit board as viewed from the second direction. Thus, the first heat radiation member is formed in a larger size and overlaps with the control circuit board. As a result, the increase in the area of the space occupied by the first heat radiation member and the second radiation member as viewed from the second direction can be suppressed.

The heat radiation mechanism may further include a heat separation member whose thermal conductivity is lower than that of the first radiation member and that of the second radiation member. The first heat radiation member and the second heat radiation member may be fixed to each other with the heat separation member held between the first heat radiation member and the second heat radiation member. According to this embodiment, the heat transference between the first heat radiation member and the second heat radiation member can be suppressed. Accordingly, the thermal effect of one of the light source and the control circuit unit on the other thereof can be suppressed. To further suppress the thermal effect, the heat separation member may have a slit, the slit being formed such that the area of contact between the first heat radiation member and the second radiation member is smaller.

The second heat radiation member may be formed such that a portion of the second heat radiation member disposed counter to an approximate center of the control circuit board protrudes more in the second direction than a portion thereof disposed counter to a predetermined edge vicinity portion of the control circuit board. Also, the first heat radiation member may be provided such that the first heat radiation member overlaps with the predetermined edge vicinity portion of the control circuit board as viewed from the second direction.

In such a control circuit board as described above, it is generally easy to gather the electronic components mounted on the control circuit board, which produce heat, in the center area. Thus, by employing this embodiment, the heat generated through the board can be efficiently radiated and, at the same time, a space near an edge of the board can be used for the first heat radiation member. Hence, the degradation in the thermal conductivity can be avoided and, at the same time, the space occupied by the first heat radiation member and the second heat radiation member can be reduced.

According to this embodiment, the heat-radiation member for radiating the heat of the light source and the heat radiation member for radiating the heat generated by the control circuit for controlling the lighting of the light source can be placed in such a manner as to effectively use the space.

FIG. **14** shows a structure of an automotive headlamp **1010** according to the eighth embodiment. FIG. **14** is a vertical cross-sectional view, of the automotive headlamp **1010**, including the optical axis Ax**1** of a lamp unit. The automotive headlamp **1010** functions as a so-called low-beam light source that forms a low-beam light distribution pattern. It should be noted that the automotive headlamp **1010** is not limited to that described above and the automotive headlamp **1010** may function as a high-beam light source that forms a high-beam light distribution pattern.

The automotive headlamp **1010** includes a projection lens **1012**, a light-emitting module **1014**, a reflector **1016**, and a shade **1018**. The projection lens **1012** is a plano-convex aspheric lens, having a convex front surface and a plane rear surface, which projects a light source image formed on a rear focal plane toward a front area of the lamp unit as a reverted image.

The light-emitting module **1014** has a light-emitting element **1020** constituted by LEDs, which function as a light-emitting apparatus and are semiconductor light-emitting elements. It is to be noted that the light-emitting element **1020** may be constituted by any other light-emitting element other than LEDs, and an electric-discharge lamp, an incandescent lamp, or the like may be used as the light source in the place of the light-emitting element **1020**. The light-emitting module **1014** is disposed such that the light-emitting element **1020** emits light mainly upward.

The reflector **1016** has a reflecting surface **1016*a*** that reflects and focuses the light emitted by the light-emitting element **1020**. The reflector **1016** is disposed such that the reflecting surface **1016*a*** is located above and opposite to the light-emitting element **1020**. The shade **1018** has a shade section **1018*a*** and a joining section **1018*b***. The shade section **1018*a*** has a plane containing the optical axis Ax**1** of the lamp unit, which defines a cutoff line near the horizontal line of the low-beam light distribution pattern. Note that a description of the shape of the shade section **1018*a***, which is known in the art, is omitted. The joining section **1018*b*** joins the projection lens **1012** to the shade section **1018***a*. The joining section **1018***b* also functions as a design-designated member which constitutes a design surface visible from the outside.

FIG. **15**A is a perspective view showing a structure of a light-emitting module **1014** according to the eighth embodiment. FIG. **15**B is a side view of the light-emitting module **1014** according to the eighth embodiment. The light-emitting module **1014** includes a package **1030**, a first heatsink **1032**, an attachment **1034**, a fan **1036**, a cover **1040**, and a control circuit board **1042**.

The package **1030** includes a light-emitting element **1020**. The control circuit board **1042** controls the lighting of the light-emitting element **1020**. According to this embodiment, the control circuit board **1042** is configured by a printed-circuit board and electrical components and elements mounted on the printed-circuit board.

The first heatsink **1032** is made of a highly heat radiant material, such as aluminum, and functions as a heat radiation member. The first heatsink **1032** has heat radiation fins **1032***a* that radiate heat generated by the light-emitting element **1020** and the control circuit unit **42**. The first heatsink **1032** is mounted on a bottom face **1034***e* of the attachment **1034**. Thus, the bottom face **1034***e* of the attachment **1034** functions as a heat radiation member mounting section.

The heat radiation fins **1032***a* of the first heatsink **1032** are provided in a lower part of the first heatsink **1032**. The heat radiation fins **1032***a* are provided in such a manner as to extend in a direction perpendicular to the optical axis Ax**1** of the lamp unit. The fan **1036** is mounted to the first heatsink **1032** below the heat radiation fins **1032***a* such that the fan **1036** can blow air to the heat radiation fins **1032***a*.

The attachment **1034** has a fixed connector **1038** integrally secured thereto by a resin integral molding. The fixed connector **1038** is so provided as to allow connection of a wire connector. The attachment **1034** also has a circuit holding section which is a downward recess to hold the control circuit board **1042**. The control circuit board **1042** is held in this circuit holding section. After the control circuit board **1042** is placed therein, the cover **1040** is attached to the attachment **1034**. It is also to be noted that the cover **1040** may be excluded. Also, in the place of the cover **1040**, the arrangement may be such that a resin molding is applied to the circuit holding section after the placement of the control circuit board **1042** therein.

The control circuit board **1042** is such that the length thereof in the direction perpendicular to the optical axis Ax**1** of the lamp unit is greater than the length thereof in the direction parallel thereto. More specifically, the length thereof in the direction perpendicular to the optical axis Ax**1** of the lamp unit is more than twice that in the direction parallel thereto. Provision of the control circuit board **1042** in this manner can reduce the length of the light-emitting module **1014** in the direction of the optical axis Ax**1** of the lamp unit, thus contributing to the further downsizing of the automotive headlamp **1010**.

The attachment **1034**, the control circuit board **1042**, and the cover **1040** constitute an attachment unit **1033**. In the eighth embodiment, the control circuit board **1042** and the cover **1040** are installed in advance on the attachment **1034** before the attachment **1034** is mounted on the heatsink **1032**, and the control circuit board **1042** and the cover **1040** are mounted on the heatsink **1032** as the attachment unit **1033**. As a result, the attachment **1034** and the control circuit board **1042** are mounted integrally on the heatsink **1032**, and at the same time the package **1030** is installed in such a manner as to be held between the attachment **1034** and the first heatsink **1032**. Thus, the attachment **1034** functions as a light source fixing member that secures the light-emitting element **1020** to the first heatsink **1032**.

As described above, the light-emitting module **1014** has the light-emitting element **1020** as the light source and the control circuit board **1042** controlling the lighting of the light-emitting element **1020** integrally structured together. Thus incorporation of the light-emitting module **1014** into the automotive headlamp **1010** realizes a simultaneous installation of the light-emitting element **1020** and the control circuit board **1042** in the automotive headlamp **1010**. This will reduce the number of processes required for the assembly of the automotive headlamp **1010**.

The package **1030** includes a light-emitting element **1020**, a submounting board, and a mounting board. The light-emitting element **1020** is mounted to the submounting board, and the submounting board is mounted to the mounting board. The mounting board is provided with a conductive member (not shown) for power feeding.

The control circuit board **1042** is disposed in a position anterior to the light-emitting element **1020** in the lamp unit. In this setting, the control circuit board **1042** in a position anterior to the light-emitting element **1020** in the lamp unit is so disposed as to be clear of the path of light used to form a light distribution pattern in all the light emitted by the light-emitting element **1020**. More specifically, the control circuit board **1042** is located in a position anterior to the package **1030** and below the cover **1040** in the lamp unit. The path of light used to form a light distribution pattern is further above the shade section **1018***a* of the shade **1018** which is placed on the cover **1040**. Therefore, the control circuit board **1042**, which is disposed below the cover **1040**, is located in a region clear of the path of light used to form a light distribution pattern.

The light-emitting module **1014** is disposed such that the main optical axis Ax**2** of the light-emitting element **1020** is oriented vertically upward. Note that the main optical axis Ax**2**, as used herein, is the axis passing through the center of the main light-emitting surface, which is the top surface of the light-emitting element **1020**, perpendicularly thereto. Therefore, the light-emitting module **1014** is so oriented that the main optical axis Ax**2** of the light-emitting element **1020** is perpendicular to the optical axis Ax**1** of the automotive headlamp **1010**. As such, the light can be efficiently cast on the reflector **1016**. Accordingly, a low-beam light distribution pattern can be formed properly by way of the reflector **1016**.

Also, the light-emitting element **1020** is so disposed that a light-emitting portion thereof protrudes higher than the control circuit unit **1042** in the direction of the main optical axis Ax**2**. The light-emitting portion includes the main light-emitting surface of the light-emitting element **1020** and the side portions surrounding the main light-emitting surface. This avoids the location of the control circuit unit **1042** in a front position anterior to the light-emitting portion in the lamp unit, thus ridding of the adverse effects on the light distribution pattern of the control circuit unit **1042** located in a front position within the lamp unit.

The cover **1040** is provided to cover the whole opening above the circuit holding section in order to prevent foreign material from entering the control circuit board **1042**. Thus, the cover **1040** is so provided as to cover the entirety of the control circuit board **1042**. However, the arrangement may be such that the cover **1040** covers only a part of the control circuit board **1042**.

The fixed connector **1038** has a connection part for connection of the wire connector **58** (See FIG. **3**) in a lower portion thereof to facilitate the connection of the wire connector **58** by moving the wire connector **58** vertically upward in a region clear of the path of light. It should be appreciated, however, that the direction of connection of the wire connector **58** is not limited to the one described above. The wire connector **58** may be connected by moving the wire connector **58** in any other directions approaching the path of light in a region clear of the path of light.

The wire connector **58** is of such structure that a wire is led out from an end thereof opposite to the end to be connected to the fixed connector **1038**. Accordingly, the wire connector **58** is connected to the fixed connector **1038** as the wire connector **58** is moved vertically upward. This allows the wire led out from the wire connector **58** to be located further away from the path of light, thereby minimizing the possibilities of the wire deforming and straying upward causing any adverse effect on the light distribution pattern.

FIG. **16** is a perspective view showing a method for assembling a light-emitting module **1014** according to the eighth embodiment. The attachment unit **1033** is further constituted by a second heatsink **1062**. The second heatsink **1062** has a circuit laying surface **1062***c* (See FIG. **21**B) on which a circuit is to be placed. The control circuit board **1042** for controlling the lighting of the light-emitting element **1020** is mounted on this circuit laying surface **1062***c*. The second heatsink **1062** functions as a heat radiation member with which the heat generated by the control circuit board **1042** is radiated. Thus, the first heatsink **1032** and the second heatsink **1062** function as a heat radiation mechanism for radiating the heat generated by the light-emitting element **1020** and the control circuit board **1042**.

The control circuit board **1042** is first mounted to the second heatsink **1062** so as to constitute a circuit unit **1060**. Then the circuit unit **1060** is secured to the attachment **1034**. After the circuit unit **1060** has been secured to the attachment **1034**, the control circuit board **1042** and a conductive member provided in the attachment **1034** are connected together by wire bonding or the like. After this, resin is filled onto the circuit for the purpose of the sealing. Finally, the cover **1040** is mounted to the attachment **1043**, thereby completing the assembly of the attachment unit **1033**.

FIG. **17** is a perspective view of the attachment unit **1033** according to the eighth embodiment. In this manner, the attachment unit **1033** is configured such that the circuit unit **1060** configured by placing the control circuit board **1042** on the second heatsink **1062** is mounted to the attachment **1034**.

FIG. **18**A is a top view of the circuit unit **1060**. FIG. **18**B is a right side view of the circuit unit **1060**. FIG. **18**C is a front view of the circuit unit **1060**. The second heatsink **1062** has a circuit support section **1062***a* and heat radiation fins **1062***b*. The circuit support section **1062***a* is formed in the shape of a flat plate whose size is approximately identical to that of the control circuit board **1042**. The control circuit board **1042** is mounted on the circuit laying surface which is the top face of the second heatsink **1062**.

The heat radiation fins **1062***b* are formed such that the heat radiation fins **1062***b* extend downward from the bottom face of the circuit support section **1062***a*. The second heatsink **1062** is formed such that a portion of the second heatsink **1062** disposed counter to an approximately center of the control circuit board **1042** protrudes further downward than portions thereof disposed counter to a vicinity of both ends of the control circuit board **1042**. More specifically, the heat radiation fins **1062***b* of the second heatsink **1062** are provided in only the portion thereof disposed counter to the approximately center of the control circuit board **1042**.

As shown in FIG. **18**A, the main components that produce heat are mounted in the center area of the control circuit board **1042**. Thus, the heat generated by the control circuit board **1042** can be efficiently radiated by using the heat radiation fins **1062***b* provided counter to a part of the control circuit board **1042**.

FIG. **19** is a top view of the attachment **1034**. The attachment **1034** includes a circuit holding section **1034***a*, fin insertion holes **1034***b*, slits **1034***c*, an opening **1034***d*, and a package securing section **1034***f*.

The control circuit board **1042** for controlling the lighting of the light-emitting element **1020** is mounted to the circuit holding section **1034***a*. Thus the circuit holding section **1034***a* functions as a circuit mounting section. The circuit holding section **1034***a* is a downward recess, and the circuit unit **1060** is secured to the circuit holding section by abutting against the bottom face of the circuit holding section **1034***a*. In order that the area of contact between the first heatsink **1032** and the second heatsink **1062** can be made small, the slits **1034***c* are formed on the bottom of the circuit holding section **1034***a*.

The first heatsink **1032** is mounted on the bottom face **1034***e* of the attachment **1034**, so that the package securing section **1034***f* holds the package **1030** between the first heatsink **1032** and the package securing section **1034***f* and thereby secures the package **1030**. As a result, the light-emitting element **1020** is secured.

The package securing section **1034***f* has an opening **1034***d*, conductive members **1064**, and plate springs **1065**. The opening **1034***d* allows the light-emitting element **1020** to pass through from below and is formed such that the light-emitting element **1020** protrudes higher than the top face of the attachment **1034**. The conductive member **1064** is so formed as to protrude toward the inside of the opening **1034***d*. The conductive member **1064** is so provided that when the first heatsink **1032** is mounted on the bottom face **1034***e* of the attachment **1034**, the conductive member **1064** comes in contact with the electrodes of the light-emitting element **1020** and thereby conducts electricity between the control circuit board **1042** and the light-emitting element **1020**. When the attachment **1034** is mounted to the first heatsink **1032**, the plate spring **1065** presses the package **1030** against the first heatsink **1032** so as to secure the package **1030** thereto. Thus the plate springs **1065** function as the pressing members that press the package **1030**.

In the attachment **1034**, the conductive members **1064** are led up to connectors **1066** of the control circuit board **1042**, respectively. Thus a part of the attachment **1034** between the package securing section **1034***f* and the connectors **1066** function as a wiring section (space) used to lead and wire the conductive members **1064**. The connectors **1066** and the control circuit board **1042** are connected together by wire bonding, whereas the conductive members **1064** are connected to the control circuit board **1042**. The conductive members **1064**, except for portions of the conductive members **1064** protruding from the opening **1034***d* and those exposed to the connectors **1066**, are molded integrally with the attachment **1034**.

The attachment **1034** has conductive members **1068**. The conductive member **1068** is connected to a connection pin of the fixed connector **1038**. The conductive members **1068** and the connection pins are formed integrally with each other. Also, the conductive members **1068** and the attachment **1034** are molded integrally with each other.

The control circuit board **1042**, the connectors **1066**, and the conductive members **1068** are connected together by wire bonding after the control circuit board **1042** has been mounted to the circuit holding section **1034***a*. As a result, the control circuit board **1042** and the light-emitting element **1020** are electrically connected to each other and the control circuit board **1042** and the connection pins of the fixed connectors **1038** are electrically connected to each other.

FIG. **20**A is a top view of the attachment unit **1033**. FIG. **20**B is a right side view of the attachment unit **1033**. FIG. **20**C is a bottom view of the attachment unit **1033**. Note that the fan **1036** is omitted in FIGS. **20**A to **20**C.

As shown in FIGS. **20**B and **20**C, the heat radiation fins **1032***a* are provided in a lower part of the first heatsink **1032**, and the heat radiation fins **1062***b* are provided in a lower part of the second heatsink **1062**. As shown in FIG. **20**C, the first heatsink **1032** has an opening **1032***b* through which the heat radiation fins **1062***b* of the second heatsink **1062** are inserted. The heat radiation fins **1062***b* are inserted through this opening **1032***b*.

The heat radiation fins **1032***a* of the first heatsink **1032** and the heat radiation fins **1062***b* of the second heatsink **1062** are provided in such a manner as to extend in parallel with a direction perpendicular to the optical axis Ax**1** of the lamp unit. The fan **1036** is mounted to the first heatsink **1032** below the heat radiation fins **1032***a* and the heat radiation fins **1062***b* such that the fan **1036** can blow air to the heat radiation fins **1032***a* and the heat radiation fins **1062***b*.

The heat radiation fins **1062***b* of the second heatsink **1062** are disposed such that each heat radiation fin **1062***b* extends along the same straight line as the heat radiation fin **1032***a*. Thereby, the space between the heat radiation fins **1062***b* can continue linearly beyond the space between the heat radiation fins **1032***a* and therefore air can smoothly flow therethrough.

FIG. **21**A is a cross-sectional view of FIG. **20**A taken along the line P-P. FIG. **21**B is a cross-sectional view of FIG. **20**A taken along the line Q-Q. In FIG. **21**A, the heat radiation fins **1032***a* are provided in front of and at the back of the second heatsink **1062**. Thus, as viewed from the direction parallel to the control circuit board **1042** such as a direction parallel to the optical axis Ax**1** of the lamp unit shown in FIG. **21**A and a direction perpendicular to the optical axis Ax**1** of the lamp unit in FIG. **21**B, the heat radiation fin **1062***b* of the second heatsink **1062** is placed such that the heat radiation fin **1062***b* thereof overlaps with the heat radiation fins **1032***a* of the first heatsink **1032**. As a result, the height of the attachment unit **1033** can be reduced as compared with the case where the first heatsink **1032** and the second heatsink **1062** are placed such that they do not overlap with each other as viewed from the direction parallel to the control circuit board **1042**, namely the case where they are placed in different positions vertically. This avoids a larger size for the light-emitting module **1014** resulting from the provision of both the first heatsink **1032** and the second heatsink **1062**.

The heat radiation fins **1062***b* of the second heatsink **1062** extend to a position approximately identical to the position of the heat radiation fins **1032***a* of the first heatsink **1032** in a direction perpendicular to the control circuit board **1042**. This enables more effective use of space in the height direction than in the case where the heights of them are made to differ from each other.

As shown in FIG. **21**A, the control circuit board **1042** is mounted to the circuit holding section **1034***a* via the second heatsink **1062** for radiating the heat generated by the control circuit board **1042**. In this setting, the first heatsink **1032** and the second heatsink **1062** are fixed to each other with the attachment **1034** held between the first heatsink **1032** and the second heatsink **1062**. Also, the second heatsink **1062** is configured such that the second heatsink **1062** is not in contact with the first heatsink **1032** when the first heatsink **1032** is mounted on the bottom face **1034***e* of the attachment **1034**.

The circuit holding section **1034***a* of the attachment **1034** is formed of a material whose thermal conductivity is lower than that of the first heatsink **1032** and that of the second heatsink **1062**. Accordingly, the attachment **1034** is formed of a material whose thermal conductivity is lower than that of the first heatsink **1032** and that of the second heatsink **1062**. Thus the attachment **1034** functions as a heat separation member for separating the heat generated by the light-emitting element **1020** from the heat generated by the control circuit board **1042** and vice versa. Placing the first heatsink **1032** and the second heatsink **1062** close to each other avoids the transfer of heat generated from one of the light-emitting element **1020** and the control circuit board **1042** to the other thereof.

Also, the heat radiation fins **1062***b* are provided such that a portion of the heat radiation fins **1062***b* disposed counter to an approximate center of the control circuit board **1042** extends downward as viewed from a direction parallel to the optical axis Ax**1** of the lamp unit. The heat radiation fins **1062***b* are not provided in an area disposed counter to a vicinity of both ends of the control circuit board **1042**. It is generally easier to locate the electronic components, which are likely to produce heat, in the center of the control circuit board **1042** than to locate them in the vicinity of both ends of the control circuit board **1042**. In this manner, the heat radiation fins **1062***b* are provided such that the portion thereof disposed counter to an approximate center of the control circuit board **1042** extends downward, and the components, which are likely to produce heat in the control circuit board **1042**, are located in the center of the control circuit board **1042**. With this configuration, the heat generated by the control circuit board **1042** can be efficiently radiated by the heat radiation fins **1062***b*.

It is appreciated that the heat radiation fins **1062***b* may be provided such that portions of the heat radiation fins **1062***b* disposed counter to predetermined positions other than the approximate center of the control circuit board **1042** extend downward as viewed from a predetermined direction parallel to the control circuit board **1042**. Also, the heat radiation fins **1062***b* may be provided such that the portions disposed counter to the predetermined positions of the control circuit board **1042** extend longer in a direction perpendicular to the control circuit board **1042** than a predetermined position other than said predetermined positions.

As shown in FIG. **21**B, the first heatsink **1032** has a projecting part **1032***c*. The projecting part **1032***c* projects upward from the circuit laying surface **1062***c* such that the light-emitting element **1020** vertically protrudes higher than the control circuit board **1042**. In the eighth embodiment, the cover **1040** and the shade section **1018***a* are located above the control circuit board **1042**. Thus the projecting part **1032***c* is formed as follows. That is, the projecting part **1032***c* projects upward from the circuit laying surface **1062***c* such that the light-emitting portion of the light-emitting element **1020** is located higher than the top surface of the shade section **1018***a*.

FIG. **22** shows a region where the heat radiation fins **1032***a* of the first heatsink **1032** are provided and a region where heat radiation fins **1062***b* of a second heatsink **1062** are provided, in the top view of the attachment unit **1033**.

As shown in FIG. **22**, the heat radiation fin **1032***a* of the first heatsink **1032** is provided such that the heat radiation fin **1032***a* thereof overlaps with a vicinity of both ends of the control circuit board **1042** as seen from a direction perpendicular to the control circuit board **1042**. As described already, the heat radiation fin **1062***b* is provided in the position disposed counter to an approximate center of the control circuit board **1042** but no heat radiation fin **1062***b* is provided in the vicinity of both ends of the control circuit board **1042**. Thus the heat radiation fins **1032***a* are provided in this space, thereby increasing the layout area of the heat radiation fins **1032***a*.

As described above, cooling the light-emitting element **1020** is in a greater need than cooling the control circuit board **1042**. Note here that the area of the control circuit board **1042** is generally wide. Thus, suppose that the heat radiation fins **1062***b* having an area approximately identical to the area of the control circuit board **1042** are to be provided so that the height required to cool the control circuit board **1042** can be set for the heat radiation fins **1062***b*. Then, the height of the heat radiation fins **1062***b* for cooling the control circuit board **1042** may possibly be smaller than the height of the heat radiation fins **1032***a* for cooling the light-emitting element **1020**. Note here also that the heat radiation fin **1032***a* and the opening **1032***b* are located at the same position as the control circuit board **1042** in a vertically direction. If, however, the heights of the heat radiation fins **1032***a* and the heat radiation fins **1062***b* differ from each other, it will be difficult to utilize a space otherwise caused by the difference in height between the heat radiation fins **1032***a* and the heat radiation fins **1062***b*.

In this manner, the heat radiation fins **1062***b* for cooling the control circuit board **1042** are provided in only a position disposed counter to a part of the control circuit board **1042**, and the heat radiation fins **1032***a* for cooling the light-emitting element **1020** are provided in positions disposed counter to other parts of the control circuit board **1042**. With this configuration, the fins having areas appropriate for their cooling necessity can be suitably provided while the difference in height between the heat radiation fins **1032***a* and the heat radiation fins **1062***b* is minimized. It should be noted that a region where the first heatsink **1032** and the control circuit board **1042** overlap with each other is not limited to the vicinity of ends of the control circuit board **1042**. For example, the first heatsink **1032** may be provided such that the first heatsink **1032** overlaps with other parts of the control circuit board **1042** as viewed from a direction perpendicular to the control circuit board **1042**.

(Ninth Embodiment)

A ninth embodiment relates to a light source fixing member and, in particular, to a light source fixing member that secures a light source to a heat radiation member for dissipating the heat generated by the light source.

In the automotive headlamps being used, for example, there are cases where a control circuit for controlling the lighting of the light-emitting elements is provided independently of the mounting substrate to which the light-emitting elements are directly mounted. Electrically connecting the light source to this control circuit promptly at the time of manufacturing leads to the improvement of the productivity. In the technique according to the above-cited reference, however, the control circuit and the light source cannot be directly connected together and the control circuit must be connected to the attachment separately. There is thus room for improvement in this regard.

The ninth embodiment is implemented to solve the aforementioned problems, and a purpose thereof is to quickly connect the light source and the control circuit for controlling the lighting of the light source.

To resolve the foregoing problems, a light source fixing member according to the ninth embodiment includes a heat radiation member mounting section mounted to a light source heat radiation member for radiating the heat of a light source, a light source fixing section that secures the light source to the light source heat radiation member by mounting the heat radiation member mounting member to the light source heat radiation member, a circuit mounting section to which a control circuit unit for controlling the lighting of the light source is mounted, and a conductive member connected to the control circuit unit. The conductive member is so provided that when the heat radiation member mounting section is mounted to the light source heat radiation member, the conductive member comes in contact with the electrodes of the light source and thereby conducts electricity between the control circuit unit and the light source.

According to this embodiment, the light source fixing member is mounted to the heat radiation member, thereby conducting electricity between the light source and the control circuit unit. Thus the number of processes required by the manufacturing personnel or the overall man-hours can be reduced.

The light source fixing member may further including a wiring section, formed of a resin, in which the conductive member is led and wired to a connector to the control circuit unit. At least part of the conductive member may be molded integrally with the wiring section. According to this embodiment, the number of processes required for the wiring of the conductive members can be reduced and therefore the productivity of the light-emitting apparatuses can be improved.

The control circuit unit may be mounted to the circuit mounting section through the medium of a circuit heat radiation member for radiating the heat generated by the control circuit unit. According to this embodiment, the heat produced by control circuit unit can be radiated independently of the light source radiation member. Thus, the thermal effect of one of the control circuit unit and the light source on the other thereof can be suppressed as compared with the heat generated by the control circuit unit and the heat generated by the light source are radiated using the same single heat radiation member only.

The circuit heat radiation member may be configured such that the circuit heat radiation member is not in contact with the light source heat radiation member when the heat radiation member mounting section is mounted to the light source heat radiation member. Also, the circuit mounting section may be formed by a material whose thermal conductivity is lower than that of the light source heat radiation member and that of the circuit heat radiation member. According to this embodiment, the control circuit unit and the light source can be electrically connected to each other through the attachment. At the same time, the control circuit unit and the light source can be thermally independent of each other and therefore the thermal effect of one of the control circuit unit and the light source on the other thereof can be further suppressed.

According to this embodiment, the light source and the control circuit unit for controlling the lighting of the light source can be promptly connected to each other.

FIG. **23** shows a structure of an automotive headlamp **1100** according to a ninth embodiment. Hereinbelow, the components identical to those of the eighth embodiment are given the identical reference numerals, and the repeated description thereof will be omitted. The automotive headlamp **1100** is configured similarly to the automotive headlamp **1010** of the eighth embodiment except that a light-emitting module **1102** is provided in the place of the light-emitting module **1014**.

FIG. **24** is a perspective view of the light-emitting module **1102** according to the ninth embodiment. The light-emitting module **1102**, which functions as a light-emitting apparatus, includes an attachment unit **1110**, a package **1030**, a first heatsink **1112**, and a fan **1114**. The attachment unit **1110** includes a control circuit board **1120**. The control circuit board **1120** controls the lighting of the light-emitting element **1020**. In the ninth embodiment, too, the control circuit board **1120** is configured by a printed-circuit board and electrical components and elements mounted on the printed-circuit board. In the ninth embodiment, too, the light-emitting module **1102** has the light-emitting element **1020** as the light source and the control circuit board **1120** controlling the lighting of the light-emitting element **1020** integrally structured together.

The first heatsink **1112** is made of a highly heat radiant material, such as aluminum, and functions as a heat radiation member. The first heatsink **1112** has heat radiation fins **1112***a* that radiate heat generated by the light-emitting element **1020** and the control circuit unit **42**. The first heatsink **1112** is mounted on the bottom face of an attachment **1122**. Thus, the bottom face of the attachment **1122** functions as a heat radiation member mounting section.

The heat radiation fins **1112***a* of the first heatsink **1112** are provided in a lower part of the first heatsink **1112**. The heat radiation fins **1112***a* are provided in such a manner as to extend in a direction parallel to the optical axis Ax**1** of the lamp unit. The fan **1114** is mounted to the first heatsink **1112** below the heat radiation fins **1112***a* such that the fan **1114** can blow air to the heat radiation fins **1112***a*.

FIG. **25** is a perspective view of the attachment unit **1110** according to the ninth embodiment. The attachment unit **1110** is comprised of an attachment **1122**, a control circuit board **1120**, and a cover **1126**.

The attachment **1122** also has a circuit holding section **1122***b* which is a downward recess to hold the control circuit board **1120** for controlling the lighting of the light-emitting element **1020**. The control circuit board **1120** is mounted to the circuit holding section **1122***b*. Thus the circuit holding section **1122***b* functions as a circuit mounting section.

In the ninth embodiment, the control circuit board **1120** and the cover **1126** are installed in advance on the attachment **1122** before the attachment **1122** is mounted on the first heatsink **1112**, and the control circuit board **1120** and the cover **1126** are mounted on the first heatsink **1112** as the attachment unit **1033**. At this time, the cover **1126** covers the entire upper side of the control circuit board **1120**. Note that the cover **1126** may be so provided as to cover at least part of the control circuit board **1120**. In this manner, the attachment **1122** and the control circuit board **1120** are mounted integrally on the first heatsink **1112**, and at the same time the package **1030** is installed in such a manner as to be held between the attachment **1122** and the first heatsink **1112**.

In the ninth embodiment, the control circuit board **1120** is located in a position posterior to the light-emitting element **1020** in the lamp unit. The light-emitting module **1102** is disposed such that the main optical axis Ax**2** of the light-emitting element **1020** is oriented vertically upward.

The attachment **1122** has a fixed connector **1128** integrally secured thereto by a resin integral molding. A fixed connector **1128** is so provided as to allow connection of a wire connector. The fixed connector **1128** is provided such that the wire connector can be connected with the fixed connector **1128** by moving the wire connector toward the front area of the lamp unit.

FIG. **26**A is a front view of the attachment unit **1110**. FIG. **26**B is a left side view of the attachment unit **1110**. FIG. **26**C is a bottom view of the attachment unit **1110**. The attachment **1122** includes a package securing section **1122***a*, a circuit holding section **1122***b*, and an opening **1122***c*.

The attachment unit **1110** is further constituted by a second heatsink **1124**. The control circuit board **1120** for controlling the lighting of the light-emitting element **1020** is mounted to the second heatsink **1124**. The second heatsink **1124** functions as a heat radiation member with which the heat generated by the control circuit board **1120** is radiated. Thus, the first heatsink **1112** and the second heatsink **1124** function as a heat radiation mechanism for radiating the heat generated by the light-emitting element **1020** and the control circuit board **1120**.

The first heatsink **1112** is mounted on a bottom face **1122***d* of the attachment **1122**, so that the package securing section **1122***a* holds the package **1030** between the first heatsink **1112** and the package securing section **1122***a* and thereby secures the package **1030**. As a result, the light-emitting element **1020** is secured.

The package securing section **1122***a* has an opening **1122***c*, conductive members **1130**, and plate springs **1131**. The opening **1122***c* allows the light-emitting element **1020** to pass through from below and is formed such that the light-emitting element **1020** protrudes higher than the top face of the attachment **1122**. The conductive member **1130** is so formed as to protrude toward the inside of the opening **1122***c*. The conductive member **1130** is so provided that when the first heatsink **1112** is mounted on the bottom face **1112***d* of the attachment **1122**, the conductive member **1130** comes in contact with the electrodes of the light-emitting element **1020** and thereby conducts electricity between the control circuit board **1120** and the light-emitting element **1020**. When the attachment **1122** is mounted to the first heatsink **1112**, the plate spring **1131** presses the package **1030** against the first heatsink **1112** so as to secure the package **1030** thereto. Thus the plate springs **1131** function as the pressing members that press the package **1030**.

In the attachment **1122**, the conductive members **1130** are led up to connectors of the control circuit board **1120**, respectively. Thus a part of the attachment **1122** between the package securing section **1122***a* and the connectors function as a wiring section (space) used to lead and wire the conductive members **1130**. The connectors and the control circuit board **1120** are connected together by wire bonding, whereas the conductive members **1130** are connected to the control circuit board **1120**. The conductive members **1130**, except for portions of the conductive members **1130** protruding from the opening **1122***c* and those exposed to the connectors, are integrally formed with the attachment **1122**.

FIG. **27**A is a front view of the light-emitting module **1102**. FIG. **27**B is a left side view of the light-emitting module **1102**. FIG. **27**C is a bottom view of the light-emitting module **1102**. As shown in FIG. **27**B and FIG. **27**C, the heat radiation fins **1112***a* are provided in a lower part of the first heatsink **1112**, and the heat radiation fins **1124***a* are provided in a lower part of the second heatsink **1124**. As shown in FIG. **27**C, the first heatsink **1112** has an opening **1112***b* through which the heat radiation fins **1124***a* of the second heatsink **1124** are inserted. The heat radiation fins **1124***a* are inserted through this opening **1112***b*. In this setting, the second heatsink **1124** is configured such that the second heatsink **1124** is not in contact with the first heatsink **1112**.

The heat radiation fins **1112***a* of the first heatsink **1112** and the heat radiation fins **1124***a* of the second heatsink **1124** are provided in such a manner as to extend in parallel with a direction parallel to the optical axis Ax**1** of the lamp unit. The heat radiation fins **1124***a* extend in the same direction as the heat radiation fins **1112***a* and therefore air can smoothly flow therethrough. The fan **1036** is mounted to the first heatsink **1112** below the heat radiation fins **1112***a* and the heat radiation fins **1124***a* such that the fan **1036** can blow air to the heat radiation fins **1112***a* and the heat radiation fins **1124***a*.

The present invention is not limited to the above-described embodiments only, and those resulting from any appropriate combination of components in the embodiments are also effective as embodiments. Also, it is understood by those skilled in the art that various modifications such as changes in design may be added to the embodiments based on their knowledge and embodiments added with such modifications are also within the scope of the present invention.

What is claimed is:

1. An automotive headlamp comprising:

a light-emitting module configured such that a light source and a control circuit unit for controlling the lighting of the light source are structured integrally with each other; and

a reflector having a reflecting surface for reflecting light emitted from the light source and collecting the reflected light,

wherein the control circuit unit is disposed in a position anterior to the light source in a lamp unit.

2. An automotive headlamp according to claim **1**, wherein the control circuit unit in a position anterior to the light source in the lamp unit is so located as to be clear of the path of light used to form a light distribution pattern of the light emitted by the light source.

3. An automotive headlamp according to claim **2**, wherein the light-emitting module including a cover for covering at least a part of the control circuit unit,

wherein the cover has a shade portion that forms a peripheral part of the light distribution pattern by shielding a part of the light emitted by the light source.

4. An automotive headlamp according to claim **1**, wherein the light source is disposed such that a main optical axis of the light source is perpendicular to an optical axis of the lamp unit and such that a light-emitting portion protrudes more in a direction of the main optical axis than the control circuit unit.

5. An automotive headlamp according to claim **1**, wherein the light-emitting module includes a fixed connector that is so provided as to allow connection of a wire connector, and

wherein the fixed connector is disposed in a position anterior to the light source in the lamp unit and clear of a path of light such that the fixed connector allows connection of the wire connector which is brought closer to the path of light through an area clear of the path of light.

6. An automotive headlamp according to claim **1**, further comprising a fan for cooling the light source,

wherein the control circuit unit has a function of controlling the drive of the fan, and

wherein the light-emitting module has a fan connector for connecting the fan to the control circuit unit.

7. An automotive headlamp according to claim **6**, wherein the light-emitting module has a single input connector through which a first control signal used to control the lighting of the light source and a second control signal used to control the drive of the fan are inputted.

8. An automotive headlamp according to claim **1**, further comprising a support member configured to support the reflector,

the support member including:

a holding section into which the control circuit unit is inserted in an anterior direction of the lamp unit; and

a securing section that secures the light-emitting module abutting an anterior position in the lamp unit after the control circuit unit has been inserted.

* * * * *